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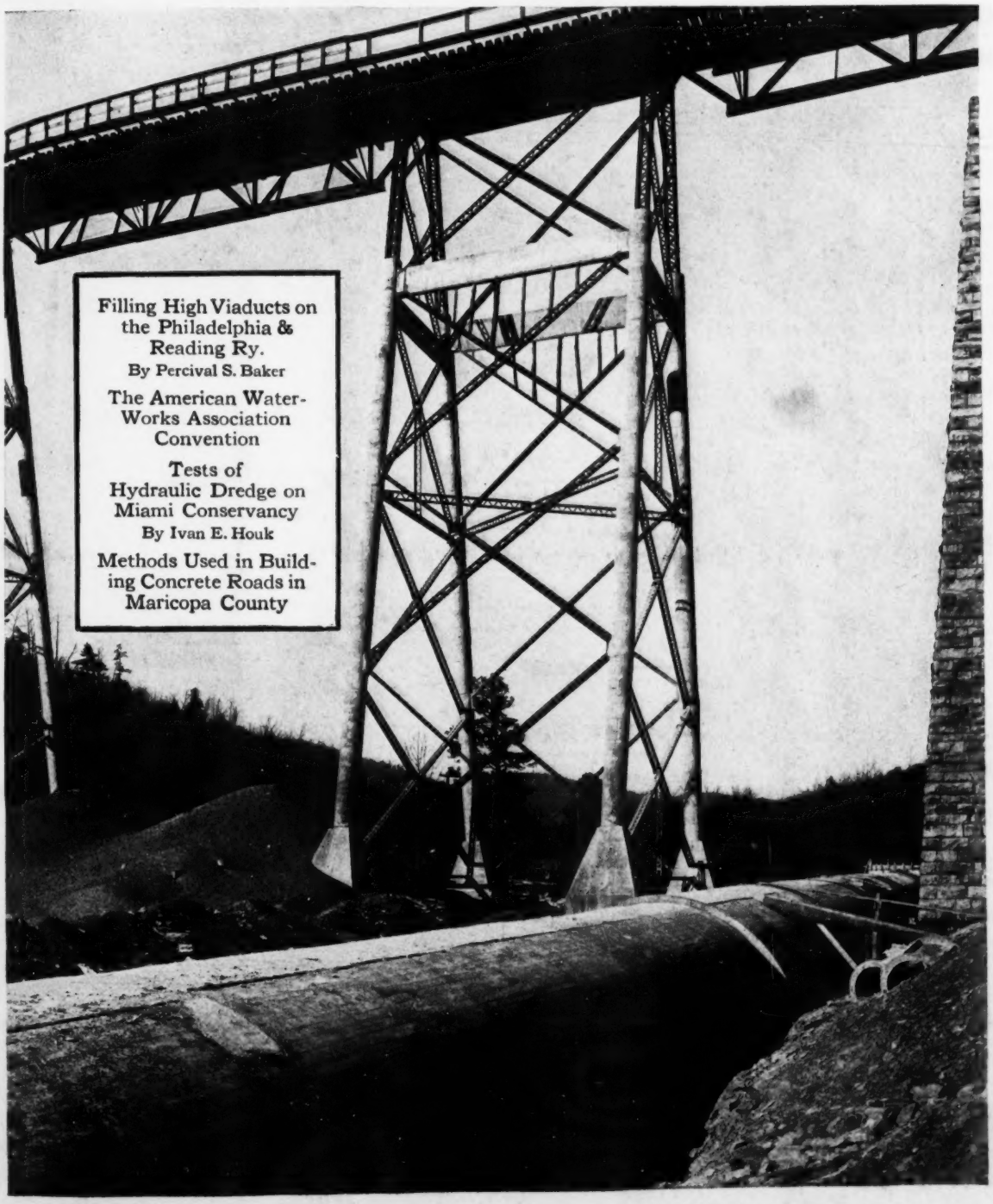

Filling High Viaducts on the Philadelphia & Reading Ry.
By Percival S. Baker

The American Water-Works Association Convention

Tests of Hydraulic Dredge on Miami Conservancy
By Ivan E. Houk

Methods Used in Building Concrete Roads in Maricopa County

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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Night Work on Concrete Roads

GREATER speed is the governing reason for any night construction work; as a rule costs and construction difficulties are increased by it. There are no figures available on how these general principles apply to the Maricopa County road work described elsewhere in this issue, but there is reason to believe that in this particular job there may be benefits not usually thought of which may be worth considering elsewhere. These are the gain in labor efficiency in the cool of the night and the possible benefit to the concrete by being permitted to take its initial set before the heat of the day. Phoenix this time of the year is a hot place, especially during the height of the sun. Men ought to be able in the cooler night to work enough faster to make up for the inevitable slowing down due to the lack of daylight. The effect on the setting of the concrete of the sun and heat is being studied, as the article indicates, but it is reasonable to suppose that the retardation of the set will be beneficial in that it will permit a longer period in which to get the water on the new concrete.

The Tribute to Ridgway

IN THE lives of few men—engineers particularly—occurs so convincing a demonstration of the esteem in which they are held as the one accorded to Robert Ridgway last week on the occasion of his promotion to chief engineer of the New York Transit Commission. Some of those who went to the Pennsylvania Hotel expecting to find assembled there a score or two of the professional associates of the guest of honor were amazed to see a gathering of almost 800. But the mere volume of attendance, impressive as it was, was not the most significant thing about the banquet. The throng which turned out to honor Ridgway represented the rank and file of the metropolitan district's engineers and contractors. Consulting engineers and commissioners rubbed elbows with rodmen and inspectors, contractors and designers hobnobbed with draftsmen and time clerks, and men in the city's engineering service were grouped at tables with corporation executives and sales engineers. Ridgway is a good engineer and a good executive, combining courage with fairness in dealings with public officials, engineers and contractors, a man who inspires implicit confidence and loyalty among his superiors and subordinates alike, but these characteristics could never have won for him the place in the hearts of his fellows which he occupies. The answer to his popularity will probably be found in the distinctly human qualities of the man. Modest almost to a fault, without a trace of self-seeking in his make-up, Ridgway has a thorough and sympathetic understanding of the problems of others—especially the young engineer and contractor, whose language he can talk and toward whom he has never been known to exhibit that patronizing manner sometimes affected by men who have reached the upper ranks of the profession.

To Study Building Costs

WITH organization preliminaries disposed of, the New York section of the National Congress of the Building and Construction Industries has turned its attention to the task for which it was formed—analyzing the industry with a view to pointing out actual conditions, and taking action to correct practices that need revision. Where to begin has been somewhat of an enigma, but it is believed the best start can be made in a series of informal meetings, each one to be given over to the discussion of a single commodity or material. For instance, it is proposed that all the essential facts about brick be discovered, every person who handles brick, from the manufacturer to the mason, taking part in the discussion. The investing public feels that brick work is too high and that it will go lower. The congress will endeavor to find out if the cost be high and, if found so, upon what factors further deflation rests. Other commodities will follow in order. As the congress is all inclusive every element, including the investing public, will have a voice in the discussions. It is needless to say the congress has a real opportunity if it gets all the essential facts. The public wants to know upon whom the responsibility rests for keeping prices so far above a pre-war level. It wants cold facts and unsensational statements. It lacks accurate information and as a result hesitates to invest. The congress can answer the question "What ails construction?" by a direct appeal to its membership. It has an opportunity to lend stability and character to its own business or to become atrophied and pass the way of legions of other investigatory bodies.

How Strong Should a Dam Be?

DAM loading is not man made or controlled, but is of the elements, whose occurrence and extent can only be guessed at and which at any time may produce conditions far in excess of any known record. The result is that whereas bridges and buildings rarely fail, except from obviously preventable causes, dam failures due to unexpected overload are always with us. Every flood like the recent one in Colorado raises some queries. How great a rainfall concentration is the engineer justified in expecting? How great an additional expense for spillway and strength against overtopping can reasonably be incurred? Is it better to risk the loss of the structure and downstream damage and loss of life or to provide insurance against the possible 50-year flood? These are questions that take dam designing out of the field of the structural expert into the realm of pure engineering judgment. Such judgment cannot be codified like law or reduced to fixed principles like science; its exercise must be special and different for each case to which it is applied. But it will help every engineer who already has—or hopes some day to have—judgmatic capabilities to put to himself for answer the question —"How strong should a dam be?"

Derailment on Curves

DERAILMENT of a locomotive on a curve, charged to excessive speed, is noted on p. 1024 of this issue, in an abstract of a report by the Bureau of Safety of the Interstate Commerce Commission. It is believed by the bureau that the speed of the train was great enough to have required an elevation of outer rail twice that provided, in order to meet A. R. E. A. recommended practice. The fact that the derailed—or overturned—locomotive came to rest on its left side, rounding a curve to the right, and the absence of wheel marks between the rails lends weight to the bureau's conclusion that actual overturning from excessive speed did occur. Moreover, it is pointed out that standing train orders permitted a speed greater than recommended by A. R. E. A. practice for the elevation of outer rail that existed. In justice to the railroad company and its engineering department, it must be recognized that exact superelevation of the outer rail—to balance overturning effect theoretically—is not the limiting factor of safety in railroad curve mechanics. The pressure of the wheel on the outer rail not only imparts holding power to the flanges, but also is probably the principal factor, rather than track fixtures, that holds the rail to the tie by friction and prevents shearing the spikes. In other words, the outer rail must guide the equipment around the curve and the greater the wheel pressure on it, the less the liability of flanges climbing and rail spreading. It is to be regretted that the Bureau of Safety of the Interstate Commerce Commission has not included a more enlightening discussion of the elements of curve mechanics in a report of this kind. The conclusions as given, without such comment, are likely to be misleading in their general application, regardless of the fact that the operating department of the railroad evidently permitted too great a speed over this line and that actual overturning evidently did occur. Moreover, such an accident emphasizes the necessity of more effective liaison between engineering and operating departments in matters so vital to both.

Progress at Philadelphia

FIRST place in the week's constructive developments must be accorded to the report of the board of engineers on the proposed Delaware River bridge to connect Philadelphia and Camden. It represents a definite step of progress in a great public improvement. The recommendations of the board pave the way for early beginning of construction work. Since the two states involved are committed to the improvement and anxious for its early realization, and since the studies of traffic, ground conditions, and structural requirements on which the report is based appear to be thorough and sane, the joint commissions of the states should not find it difficult to reach a decision. In the main point of contention, the location of the crossing, the engineers have found that the most advantageous solution is intermediate between the two that have been most strongly advocated, and it may therefore be expected that the contending parties will be more ready to accept the recommended location than they would be if an extreme location had been chosen. A large expenditure will be necessary, nearly $30,000,000 in fact; but the funds are available, and no one familiar with the situation can doubt that the bridge will make returns commensurate with its cost. The outstanding fact is that the Delaware, which now lacks a road bridge below Trenton, is one of the main stream barriers in the East. It separates the rich territories of New Jersey and Pennsylvania; and, almost equally important, it cuts across important communication routes leading from New England and New York to the West. Repeatedly attention has been called by *Engineering News-Record* to the restricting influence of the major stream barriers upon the development of highway transportation. The Camden-Philadelphia bridge will eliminate one of these barriers.

Concrete in Sea Water Once More

NO ONE can quarrel with the excellent rules for securing durable reinforced concrete in sea water laid down by Kenneth Allen in his report to the Board of Estimate of the City of New York, as recorded in this issue. It is probably a fact that if one assumes "strict compliance with these rules, reinforced concrete may be safely used in marine work." The crux of the problem lies in the words "strict compliance." Mr. Allen himself truly says that "to secure dependable work practically 100 per cent excellence is required." In this fallible world there is no such thing as practically 100 per cent excellence, and the degree by which perfection is not reached is the measure of failure of reinforced-concrete structures in sea water. Such failure has been so great in existing structures that it is remarkable that so many engineers continue to express confidence in their own ability to produce reinforced concrete that will stand up under marine exposure.

The issue has been greatly confused by past studies and by offhand opinions. There is little question today regarding the possibility of making plain concrete which will resist sea water attack. Chemical and electrical dangers are probably quite small so far as a dense concrete is concerned but a whole literature relating to these factors serves to divert emphasis from the fact that the serious danger is in reinforced-concrete frameworks, generally of slender members but always where the steel is reached by corrosive influences that cause failure due to localized rupture and not to general disintegration. A large percentage of such structures in sea water today are in a state of progressive failure in the space which is alternately wet and dry.

This is the serious problem and one which will not be solved merely by insisting that such concrete must be made 100 per cent perfect. Probably in most of these structures the concrete was none too good under present-day standards. At the same time there is little qualitative data which would demonstrate beyond doubt that the complete observance of all of the latest rules of reinforced-concrete manufacture will produce a structure which will not be attacked by the disintegrating force of the ocean.

What is needed in this subject more than anything else is an exhaustive study, such a study as was started by Messrs. Wig and Ferguson some years ago and which was reported partly in *Engineering News-Record*. Many of the data these two investigators obtained are buried in governmental archives. Some have been published in official documents, but what is available to most engineers are merely the conclusions. These studies should be supplemented now by some further similar investigations which will take up actual structures, their composition and their behavior, and not draw the conclusions from generalities. We want something definite on the effect of varying degrees of salinity, on the possibilities

in surface coatings such as paraffin, gunite, asphalt paint, etc., on the destructive power of salt spray, on the proper embedment of the steel and on the possible effect of vibration, always assuming the concrete itself to be of the best.

Such a study should be backed and furthered mostly by those who are interested in reinforced concrete and its constituent materials. Every ocean reinforced-concrete structure which is going to pieces—and many of them are in public places where they are seen by thousands of people—is a setback to the use of concrete everywhere. Even among engineers the difference between the problem of concrete and of reinforced concrete in sea water is generally overlooked. How much more is it to be expected that the layman will overlook the differences between ocean reinforced concrete and inland concrete? There is little good in continually maintaining that it is possible to build perfectly safe reinforced-concrete structures in and around the ocean and if such structures are not being built. Experience is a considerably better advertiser than prophecy.

Engineering Studies for Flood Protection

CONTROL of the weather is as yet beyond man's power. Fortunately or unfortunately, he has not been able to discover means for making the sun shine or the rains come down. And so long as this limitation shall continue, flood rains will deluge the earth from time to time, now in one region, now in another. The meteorologist cannot even predict them, much less prevent. Dependence for protection from floods must rest in the prevision and planning of engineers.

Of the possibilities of flood-producing rainfall, only a small part is known, despite vast amounts of study that have been given to the problem. In the past engineers have had to concern themselves mainly with two extreme phases of the question: the flood of the brook or rivulet, with a drainage area of a few square miles or at best a few hundred, caused by intense local showers; and the great flood of a river system, resulting from slow, long-continued rains. At every road or railway embankment the engineer encounters numberless culverts and small bridges whose waterways he must proportion for local freshets, and many observations have been compiled and many rules formulated for determining the greatest runoff per square mile from a small drainage area. Equally patient study, but of radically different kind, has been applied to the great trunk streams, as the Ohio and the Mississippi, in accordance with the fundamental difference in the conditions from which their floods result. Streams and drainage areas of intermediate size, however, have received almost no attention with respect to flood.

Because of this absence of knowledge the investigations consequent upon the Central States flood of 1913 had to go back to the original data of rainfall observations. It was a laborious research, but it yielded results of remarkable value. In the light of these results it was seen to be urgently necessary that similar studies of flood and protection possibilities be made in other river valleys throughout the country. Since that time, however, the importance of this work has been lost sight of, until now the Colorado floods bring it back abruptly to the general consciousness.

In these disastrous regional floods we are dealing with phenomena of extremely rare occurrence. The Miami investigations, just referred to, pointed to the inference that the 1913 flood conditions of southwestern Ohio would probably not recur oftener than once in a hundred or two hundred years in any single drainage basin of the Central States. But in the eight years since then, no similar regional flood has occurred throughout the length and breadth of the United States, and it may develop that the probabilities of extreme flood rainfalls of the kind in question are even more remote than the engineers concluded. It is probable that the Pueblo precipitation was not nearly as severe and widespread as that of 1913; yet its effects prove it to have been a rainfall of extremely rare occurrence.

The construction of engineering works to prevent floods or minimize their destruction is not something that can be taken in hand at a moment's notice. Not only must the works be planned with elaborate care, but the engineer cannot even tell what works are practicable, if any, until he has investigated in detail all the conditions involved; there is no fixed formula for flood protection. Protective works may prove to be too expensive; in this case, however, the engineer can minimize the danger by predetermining its amount and frequency, and by suggesting how the community may keep out of the flood path. In any event, nothing whatever can be done with respect to the flood menace, not even sound private or public planning, until the engineer has made his study.

Obviously the time for such study is before the flood arrives—and the flood comes unheralded. That is why the subject of flood studies is urgent despite the variety of great floods and why it is a matter of national concern. In the interests of conservation of our resources in human life as well as in property, flood studies should be initiated all over the country, in every meteorological zone and in every stream valley.

Half the required investigation, that comprising the purely meteorological studies, is obviously a national one, and through the Weather Bureau, the Geological Survey and similar offices it can be dealt with most capably. The other half, the local study of what works should be provided and can be provided to control floods, remains a local, that is a regional, responsibility. It should not prove impossible as a practical matter to divide and yet co-ordinate the local and national studies. Joint effort could produce quick results.

One vital point, well known though not always consciously perceived, is entitled to careful reflection: Flood protection is not wholly a matter of dollars and cents. Its importance lies as much in public morale, as affected by security from sweeping disaster. It may often be a fine point to decide whether the amount of damage done by a flood—even when it runs into as many millions as the Colorado damage—will warrant huge expenditures for protection, in view of the likelihood that many decades will elapse before the works can produce returns by preventing a repetition of the destruction. But the paralysis of human effort and initiative that results from a flood is a factor that can not be ignored.

Flood visitation places a blight on the spirit of the region affected that may for long time check its development and reduce its contribution to the nation's advance. To prevent this paralysis, to inspire farmer, manufacturer, and business man with the confidence, is alone sufficient to justify large investments in engineering studies and flood-protective construction.

Filling High Viaducts on the Philadelphia & Reading Ry.

Maintenance Difficulties and Waste Disposal—Design of Culverts for 120-Ft. Embankment—Compression of Fill Deforms Viaduct Towers—How the Trouble Was Overcome

By Percival S. Baker
Engineer of Bridges and Buildings, Philadelphia & Reading Ry., Philadelphia

ON THE Catawissa branch of the Philadelphia & Reading Ry., which was constructed between the years 1835 and 1838, there were originally seven high wooden viaducts. These were renewed from time to time in timber, but finally in 1898 six of them were replaced by iron structures, while the seventh was replaced in 1901 by a steel structure. All the structures are now in course of replacement by earth fills. Certain difficulties experienced in the course of the replacement, and the expedients devised to deal with these difficulties are dealt with in the present article.

In general all of the viaducts were designed in accordance with the usual practice, being a series of 35-ft. tower spans and 85-ft. intermediate spans. The 85-ft. spans were deck riveted trusses, and the other spans were deck plate girders. Each tower was composed of two bents connected by longitudinal bracing, each bent being made up of two columns battered transversely connected by the usual transverse bracing. The columns were two 15-in. channels and the bracing two 3½-in. angles, both with single lacing. The six earlier viaducts were designed for a loading equivalent to approximately Cooper's E40, the seventh for a loading of approximately E50. These viaducts and the distances between them are:

	Length, Ft.	Height, Ft.
No. 1, Dark Run Viaduct, south of Ringtown, (2.1 mi.)	568	52
No. 2, Ringtown Viaduct, north of Ringtown, (8.2 mi.)	1,078	120
No. 3, Stranger Hollow Viaduct, north of Beaver Valley (1.4 mi.)	434	94
No. 4, Long Hollow Viaduct, south of Shumans, (3.2 mi.)	746	129
No. 5, Mine Gap Viaduct, north of McAuley, (0.4 mi.)	589	105
No. 7, Fisher's Viaduct, north of McAuley, (1.3 mi.)	757	120
No. 8, Mainville Viaduct, south of Mainville	723	101

The line on which these viaducts are located is single track and carries a very heavy southbound freight traffic, while passenger service is limited to two trains per day. It passes through a mountainous section for a considerable portion of its length and has a ruling grade against southbound traffic of approximately 0.7 per cent, which extends continuously for a distance of 35 miles. All the viaducts are located in this territory, and within a length of 16½ miles.

On account of the traffic and grade conditions the company was desirous of using heavier locomotives, but was unable to do so because of the viaducts. This fact and the availability of a large amount of filling material led to the decision to fill the viaducts. On a railroad like the Philadelphia & Reading, which serves a thickly settled portion of the country containing several highly developed industrial centers, there is offered almost continuously a large amount of industrial dirt for disposal. It is at times difficult to find suitable places to waste this dirt as well as the accumulation of railroad ashes. The filling of the viaducts therefore accomplished a double purpose.

FIG. 1. TYPICAL VIADUCT ON CATAWISSA BRANCH
Fishers Viaduct, or Bridge No. 7. Dumping has been begun at ends. Several bents are already encased, and forms are in place on another.

The ravines crossed by the viaducts contain relatively small streams, so that culverts of moderate size were sufficient for the flow. These culverts vary from a 4-ft. box to a 15-ft. arch. The arch under Fishers Viaduct is 12 ft. in span; its details are shown in the accompanying drawing, Fig. 3. The ring is designed to carry the entire load of the fill above it and is stable without the steel reinforcement, which was added to prevent temperature cracks.

Work was started on Dark Run Viaduct in 1916 and completed in June, 1917. The filling was made in the

usual manner; that is, a line of bottom-dump cars was run onto the viaduct and dumped through the floor, every third of fourth tie having previously been removed. No special care was taken, except the precaution to keep the filling approximately level across the ravine. All the metalwork including the girders was buried in the fill and the bridge ties were left in place carrying the track. No trouble of any kind was experienced, and traffic was not interrupted throughout the work.

Filling Disturbs Track Alignment—Immediately after the completion of this first fill, work was started on Stranger Hollow and carried forward in a manner similar to that employed at Dark Run. In this case the filling progressed satisfactorily until it had reached to within 10 ft. of the rail. Then, however, the track began to get out of line and surface, settling considerably at some points. The track was blocked up and the filling pushed to completion without causing any serious delays to traffic.

The next one to be filled was Long Hollow Viaduct. Filling was started in March, 1918, and for a time progressed rather slowly on account of the delay in the completion of the 15-ft. arch culvert to carry the stream. The same methods were adopted here as in the two preceding cases: A line of bottom-dump cars was run out onto the bridge and the material dumped through openings made between the ties; without any attempt to spread the material after it was dumped, although the unloading was so arranged that the top of the fill was maintained approximately level throughout the length of the viaduct. Various kinds of filling material were used, including waste from industrial plants, earth, clay, ashes and mine rock, but care was taken that no heavy masses struck the tower bracing.

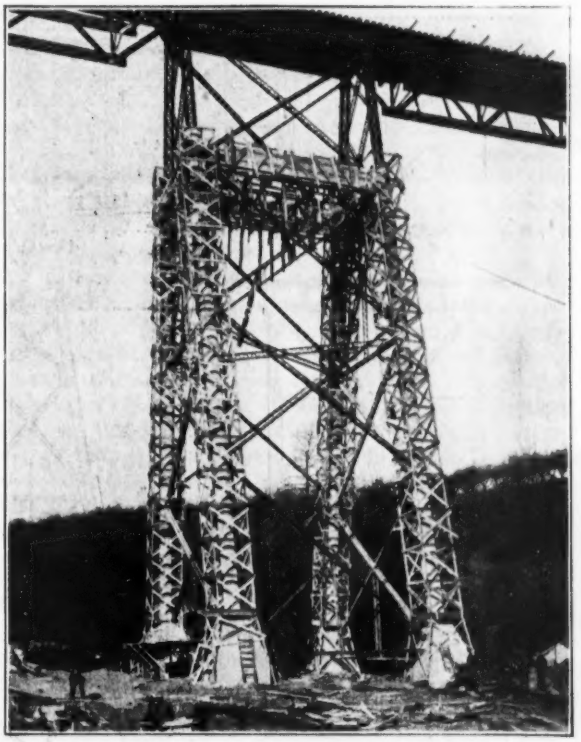


FIG. 2. PLANT FOR ENCASING COLUMNS TO STIFFEN THEM AGAINST DEFORMATION BY EARTH FILL

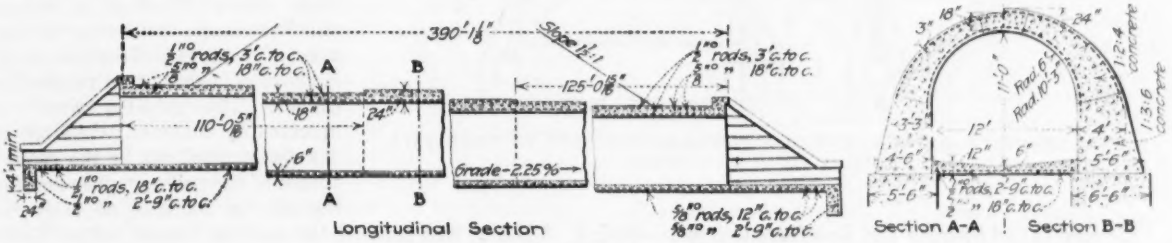


FIG. 3. CULVERT FOR VIADUCT NO. 7

High Tower Columns Distort—When the Long Hollow fill reached a height of about 50 ft., it was noticed that one column in a high tower was beginning to bend, causing the lattice bars to buckle at that point. This point was just below a connection with the longitudinal bracing, and a few feet above the line of the fill. On studying into the cause of this bend, it was conjectured that it was due to the load on the longitudinal bracing members bending them down and thus pulling the columns together. An attempt was then made to support the bracing with timber, but there was no solid foundation, and as the filling progressed it was found that this timbering was a failure.

As soon as the bend in the column was discovered traffic was reduced, and a timber bent was erected to carry the truss supported by this column. A few days later it was found that other columns were bending. Traffic was immediately abandoned over the bridge, and timber bents were erected to support the superstructure. Some of these bents were from 60 to 70 ft. high and were blocked on the fill already placed. Consequently considerable trouble was anticipated. Filling was continued as rapidly as possible. All through traffic was detoured by another route, the only traffic allowed on the structure being the local freight and two passenger trains, all hauled by light engines, and at times even these were forbidden to cross.

As the fill progressed the timber bents settled, owing to the compression of the material under them, in some cases as much as 6 ft. This settlement was not uniform, most of the bents moving to the right or left. Constant blocking and wedging was necessary to keep the superstructure up to a fairly even grade. In the meantime the iron bents were continuing to bend, and it was found that they were exerting a heavy pull on the superstructure, instead of being a support. The connections at the column caps were therefore cut, and there was immediately noticed a decided improvement, as much less difficulty was experienced in keeping the track to line. As soon as these connections were cut, the iron columns at once began to move rapidly and some column caps were soon 6 ft. from their former position.

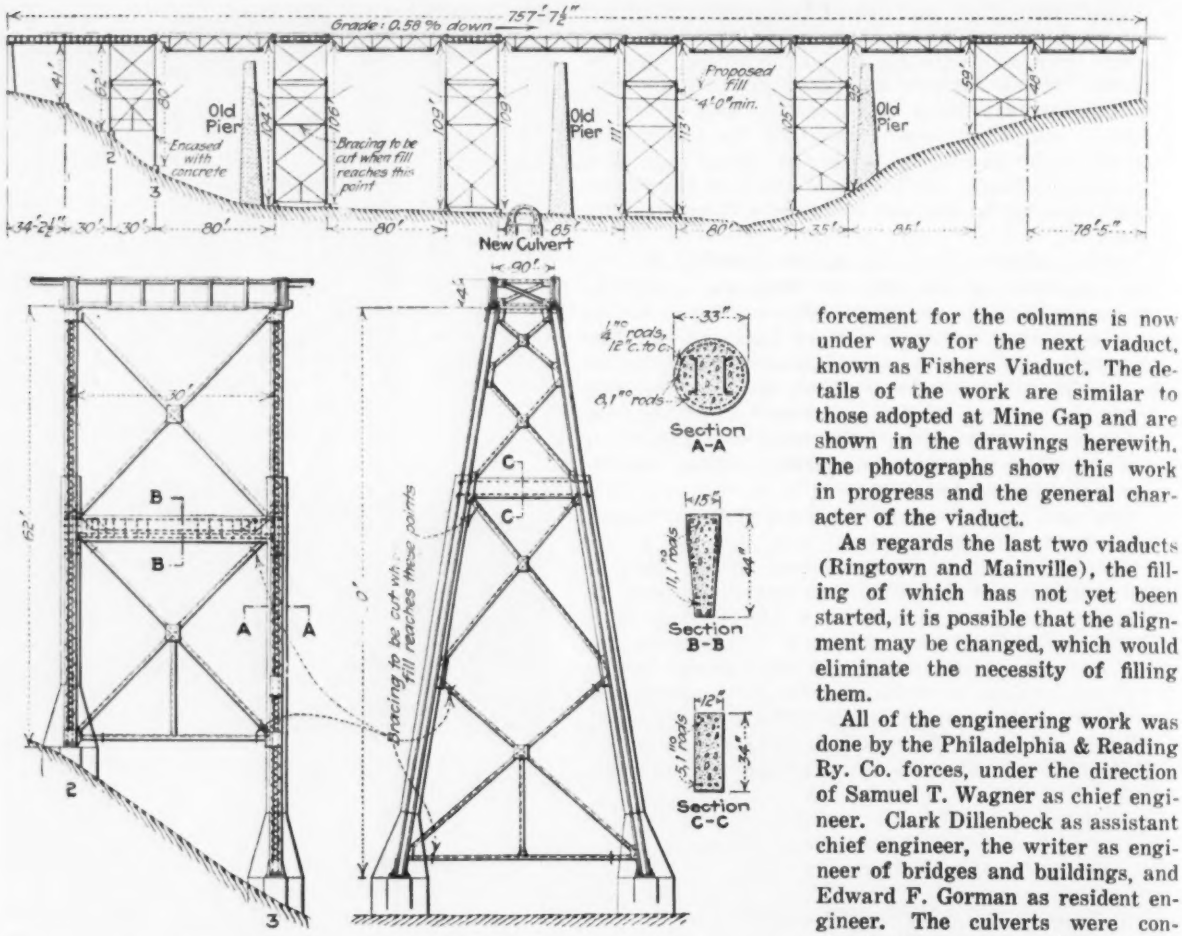


FIG. 4. STRUCTURAL PRECAUTIONS AND FILLING METHOD TO FORESTALL DEFORMATION OF TOWERS

Decide to Cut Bracing and Reinforce Columns—Owing to the difficulties experienced in filling Long Hollow Viaduct, a careful study was made before attempting to fill the next one, known as Mine Gap Viaduct. Several studies were made, based on two general principles, one being to support the bracing from the ground up, either by timber or concrete; the other, to reinforce the columns and cut the bracing as the fill progressed. The latter method was adopted.

In detail this method consisted in encasing each column in reinforced concrete, 33 in. in diameter, extending from the base to a point about 20 ft. below the cap. Reinforced-concrete struts were placed at these points in both the longitudinal and transverse planes, these struts being made strong enough to carry the load of the fill above them. In placing the fill, material was dumped only between the towers, and then shoveled into the towers in order that at all times the surface of the fill within the towers should be level for an area extending four feet beyond the lines of the columns. This was done to obtain, if possible, a vertical settlement of the fill and eliminate lateral pressures on the columns as much as possible. The filling of this viaduct has now been completed without any interference to traffic whatever.

Construction of the concrete culvert and the reinforcement for the columns is now under way for the next viaduct, known as Fishers Viaduct. The details of the work are similar to those adopted at Mine Gap and are shown in the drawings herewith. The photographs show this work in progress and the general character of the viaduct.

As regards the last two viaducts (Ringtown and Mainville), the filling of which has not yet been started, it is possible that the alignment may be changed, which would eliminate the necessity of filling them.

All of the engineering work was done by the Philadelphia & Reading Ry. Co. forces, under the direction of Samuel T. Wagner as chief engineer. Clark Dillenbeck as assistant chief engineer, the writer as engineer of bridges and buildings, and Edward F. Gorman as resident engineer. The culverts were constructed by contract, while the filling was carried out by the roadway forces of the railway. The reinforcing of the columns of Mine Gap Viaduct was done by the railway forces, but at Fishers Viaduct it was made a part of the culvert contract.

Truck Speed Rating and Standard Body Weight Allowances

At a recent general session of the motor truck members of the National Automobile Chamber of Commerce new standards for body weight allowances, gross weight, chassis, body and freight load, and new standdards for speed were adopted. Under the new standard demonstration charges for commercial vehicles embodied in standards adopted in 1912 are eliminated. The standard speeds are now: for trucks, including gross weight, chassis, body and freight load, equipped with pneumatic tires, up to 28,000 lb. total weight, 25 miles per hour; solid rubber tires, up to 4,000 lb., 25 miles per hour; 8,000 lb., 20 miles per hour; 12,000 lb., 18 miles per hour; 16,000 lb. 16 miles per hour; 20,000 lb. and over, 15 miles per hour. These speed ratings are to be recognized by the manufacturers as the maximum and are not to be exceeded under any conditions. Body weight allowances adopted are: for 1- and 1½-ton trucks, 1,200 lb.; 2 and 2½ tons, 1,500 lb.; 3, 3½ and 4 tons, 2,000 lb.; 5 tons and over, 2,500 lb.

Plastic Gypsum Made Possible by a New Method

Public Patent Soon to Be Made Available Gratis Will Permit of Gypsum Being Used for Finish Coat of Plaster

By Warren E. Emley
Chemist, Bureau of Standards, Washington, D. C.

A GOOD JOB of wall plaster is composed of three coats, which are known to the trade as "scratch," "brown," and "finish." The scratch coat is next to the lath, the brown coat in the middle, and the finish coat is applied to the exposed surface to give the plaster a pleasing appearance.

The quality requirements put upon material for the finish coat are peculiar. It must be very plastic in order that it can be spread in a thin layer (⅛ in.) over the brown coat, which has set and is partially dry; and it must be set in 20 or 30 minutes, in order that the plasterer may finish trowelling it without moving his scaffold.

The scratch and brown coats may be composed of either gypsum and sand or of lime and sand, but the finish coat must consist of both lime and gypsum. The lime is necessary to give the proper degree of plasticity, the gypsum to make the material set with sufficient speed. The weight of the finish coat is very small in comparison with the weights of the other two coats. If the specification calls for gypsum plaster, the contractor must provide enough gypsum for all three coats and a little lime to be mixed with some of the gypsum for the finish coat. Similarly, a small amount of gypsum must be provided to be mixed with the lime in the finish coat, when lime plaster is specified. The purchase of this small amount of a second material is an expensive nuisance, and is excusable only on the grounds of necessity. To add to the trouble, it seems impossible to get good results with a ready mixed lime gypsum finish. The lime must be soaked with water for at least 24 hours in order to develop its plasticity, and the gypsum cannot be soaked because it would set. This means that the materials must be prepared separately and mixed just before using, thereby requiring additional labor and equipment.

Would Decrease Cost

The superior plasticity of lime indicates also its superior sand carrying capacity. If lime and gypsum are selling at about the same price, the fact that lime may carry three parts of sand for scratch or brown coat work, while gypsum may carry only two, makes the lime plaster much cheaper. At the same time, the superior plasticity of the lime may reduce the labor cost of application of the plaster considerably below that of gypsum. This difference in sand carrying capacity is recognized by the prevalent custom of adding 10 to 15 per cent of hydrated lime to neat or sanded gypsum plasters by the gypsum manufacturers.

From the above statements, it will appear that if gypsum can be made as plastic as lime, (1) It will not be necessary to add any lime to the gypsum for use as a finish coat. (2) The differential in favor of lime, due to its greater sand carrying capacity, will be overcome. (3) It will not be necessary for the gypsum manufacturer to add lime or any other foreign material (except retarder) in the preparation of neat gypsum plaster. These results are greatly to be desired, not only by the gypsum industry, but also by the general public, because they would tend to decrease the cost of an important building material.

Accordingly, work was started on an attempt to make gypsum as plastic as lime. The first successful experiment was completed on Sept. 13, 1920, and since that date, sufficient work has been done to make sure of the practicability of the method. The problem may therefore be considered solved, insofar as it can be with laboratory equipment.

The first thought was that plasticity is in some way dependent upon extreme fineness, and that fine grinding might solve the problem. Fine grinding, however, is not new in the gypsum industry, and it would seem strange that any increase of plasticity due to this method of manufacture could have passed unnoticed. Further investigation showed that all attempts at severe grinding on a practical scale had been conducted in a buhr mill or a tube mill. It has long been known that gypsum can be decomposed by grinding: that the water of crystallization can be ground out of it. When gypsum is ground in either of the above types of mills, the current of air passing through the mill carries off the water as fast as it is liberated. If the grinding is sufficiently severe to liberate all of the water, the resultant product is known as "soluble anhydrite." This is a peculiar form of anhydrous calcium sulphate. It differs from the mineral anhydrite in its great affinity for water. So great is this affinity that a very short exposure to moist air is sufficient to change it back to "calcined gypsum," or plaster of paris. The result is that when gypsum is ground in the usual type of equipment, either the grinding is not sufficiently severe to liberate the water of crystallization, in which case the size of the grains is not greatly reduced, or, if the grinding is severe enough to liberate the water, the final product soon absorbs water from the air and goes right back to where it started from.

Effect of Grinding

When calcined gypsum is subjected to grinding under such circumstances that the water is liberated but is not permitted to escape from the system, an entirely new product results. No satisfactory explanation has yet been evolved, but the fact remains that the product is plastic. Up to a certain limit, the degree of plasticity seems to depend upon the duration of grinding. Fortunately this limit is well beyond the plasticity of the best lime putty, so that this process enables us to make calcined gypsum more plastic than lime.

The plasticimeter described in Bureau of Standards Technologic Paper No. 169 is not yet adapted to measure the plasticity of unretarded calcined gypsum: the material begins to set before the experiment can be completed. Use has therefore been made of the Carson blotter test, as described in the Transactions of the National Lime Manufacturers Association for 1916. This has proved quite satisfactory as a means of differentiating between the plasticities of finishing hydrate and masons hydrate. When tested by this method, this "plastic gypsum" proves to be more plastic than the best lime putty.

Besides improving the plasticity, the process also causes certain changes in other properties of the material. The increased fineness of the plastic gypsum naturally necessitates the use of more water to bring the paste to a given consistency. Yet, in spite of this excess

water, the set material will average about 20 per cent stronger than that made from ordinary calcined gypsum. The process slows down the setting reaction somewhat. The time of set of one sample was changed from 12 to 17 minutes by this kind of fine grinding. Commercial calcined gypsum usually deteriorates somewhat on storing. It tends to work "lean" and carry less sand. Samples of this plastic gypsum have been exposed to the air for four months without apparent deterioration of their plasticity.

The process has been applied with equal success to calcined gypsums from Nova Scotia, New York, and Virginia. It would seem, therefore, that the original quality of the material is of little importance.

The laboratory results have been accomplished by grinding the material after calcination, the grinding being conducted in a ball mill, so that the water could not escape. Commercial calcined gypsum is always ground during the course of manufacture, either before or after calcination, so that the grinding required to make plastic gypsum need not entail the installation of an extra process. It would seem, however, that the grinding should be done after calcination rather than before. An attempt to grind before calcination liberated so much water that the powder became damp and "balled up" in the mill.

It is probably not essential that a ball mill be used: a buhr mill or tube mill may be satisfactory if enough water is added to make up for that lost by evaporation during the grinding. The essential part is that the product as it leaves the mill shall contain approximately the same quantity of water as commercial calcined gypsum does: 9 parts by weight of water to 136 parts of calcium sulphate, or about 6.2 per cent water, if the material is pure.

Individual Manufacturing Problems

The duration of grinding required to make plastic gypsum depends upon the kind of equipment used, the fineness and hardness of the material, and the degree of plasticity desired. This problem must be worked out individually by each manufacturer for his particular equipment and material. It is a very simple matter to continue the grinding until the Carson blotter test shows the material to have the desired degree of plasticity. If the grinding equipment is continuous, arrangements can easily be made to pass the material through the mill more slowly. From the results of our laboratory experiments, it would seem that the output of any grinding equipment will be considerably reduced, perhaps cut in half, if the same equipment is used to make plastic gypsum.

As a summary of the above, it may be stated that a process has been developed whereby calcined gypsum can be made as plastic as lime. This does not necessarily require the installation of additional equipment, nor the introduction of any additional step in the usual process of manufacture. The chief item of cost lies in the possible decrease of output. The plasticity is not dependent upon the addition of any foreign material. The product is identical with commercial calcined gypsum in all its important properties, except plasticity, and can be retarded or accelerated in the usual way.

The new product, "plastic gypsum," was demonstrated at the annual meeting of the Gypsum Industries Association on December 15, 1920, but the process of manufacture was not divulged. A patent, covering both the process and the product, has been applied for, and, if granted, will be given to the public for the free use of anyone in the United States. This description of the process is being released at this time in order to give additional protection to the public interest.

Locomotive Overturned Rounding Curve

OPERATION at excessive speed on a curve of 8 deg. 38 min., with elevation of outer rail 4⅜ in., caused the overturning of a locomotive and the derailment of a passenger train near Bennington Station, Pa., on the Pennsylvania R.R., April 27, 1921, according to the conclusion drawn in the report of the accident recently issued by the chief of the Bureau of Safety of the Interstate Commerce Commission. While the statements of most of the witnesses did not indicate that the speed was much in excess of 25 or 35 miles an hour, it is believed by the bureau that the conductor's estimate of 40 to 45 miles an hour more nearly approaches the actual speed of the train at the time of the accident, and this view is supported by the condition of the wreckage and the absence of wheel marks of any kind on the ties at the point of derailment. The fireman and the engineer were killed and twenty passengers and one employee injured.

Approaching the point of accident from the west, the track is tangent for 2,167 ft., followed by a curve of 8 deg. 38 min. to the right, 1,285 ft. in length. The derailment occurred about 455 ft. from its western end, at which point the grade is 1.73 per cent descending for eastbound traffic. Track in the vicinity is laid with 130-lb. rail, 33 ft. in length, with eighteen oak ties to the rail length, tie plated, single spiked, and ballasted with a mixture of slag and cinders. Standing orders limit speed to 30 miles an hour within the territory.

According to the conductor, the train was traveling faster than usual just before the accident and he estimated the speed at the time of the accident to have been from 40 to 45 miles an hour. The engine came to rest on its left side about 300 ft. beyond the point of derailment, but all the coaches remained upright, although derailed. It was thought by the track supervisor who reached the scene of the accident shortly after its occurrence that it was due to excessive speed, since no wheel marks on the ties were found nor evidence of any obstruction on the track. Track walkers had covered this portion of the line less than two hours before the time of the accident. The engine was of the 4-6-2 type, having a total weight of 308,890 lb., a driving wheel base of 13 ft. 10 in., and a total length of 48 ft. 3 in.

The division engineer calculated that the equipment involved would overturn at the point of accident at a speed of 66.4 miles an hour, based on calculations not taking into account any slight shifting of the center of gravity of the locomotive due to lateral motion, slight irregularities in track, the effect of water in the boiler, etc. He expressed the opinion that a speed of from 50 to 55 miles an hour would have been unsafe. According to the recommended practice of the American Railway Engineering Association, on a curve of 8 deg. 38 min., an elevation of 5½ in. should be provided for a speed of 30 miles an hour; for a speed of 35 miles this elevation would be approximately 7 in., and for 40 miles, approximately 9½ in.

Economics of City Planning for Small Towns

Layout Designed Arbitrarily or to Meet Local Conditions—Street Width in Relation to Taxes and Buildings

GOOD and bad examples of city plans or street layouts are illustrated by the accompanying maps, reproduced from an article by A. G. Dalzell in *Town Planning and Conservation of Life*, published in Canada by the Commission of Conservation. The following is an abstract of the article:

The Loveland Farms development at Youngstown, Ohio, Fig. 1, is planned to fit the site, to have street widths suitable for their purpose, to reserve natural beauty spots for park purposes and to centralize business in a suitable location. Also, by enforcing building lines and restrictions, to insure that all buildings are placed properly on the land so that every property owner is assured of adequate light and air and a reasonable safeguard against the spread of fire.

On the other hand the plan, Fig. 2, of Ladysmith, B. C., a mining community on Vancouver Island, is the usual type of rectangular street development so common in the prairie

FIG. 1. CITY PLAN DESIGNED TO MEET CONDITIONS: LOVELAND FARMS, OHIO

sections of western Canada, but in this case the defects are greatly intensified because the plan is superimposed upon a hilly site. The axis seems to have been determined by the railway which forms the northern boundary of the city, but better street grades would have been secured if this axis had followed the cardinal points of the compass.

From the accompanying table showing the utilization of the area it will be seen that Loveland has the advantage of economy in street area and has more land available for communal enjoyment. Assuming that street costs are equally apportioned among lot owners in proportion to the area of the lot, and taking the standard of 800 sq.yd., as in Ladysmith, the lot owner in that city would be responsible for 693 sq.yd. of street whilst the owner of a similar lot in Loveland would be responsible for 271 sq.yd. only. At Loveland, by planning the streets to fit the site, economy in grading and drainage and general construction is assured, whereas in Ladysmith, topography not having been considered, the street grades run as high as 23 per cent and street construction is correspondingly expensive.

At Loveland, the business square and the community center are on a high level plateau, accessible from all directions by streets of easy grade. In Ladysmith, the so-called "market square" is useless both as a business and recreation

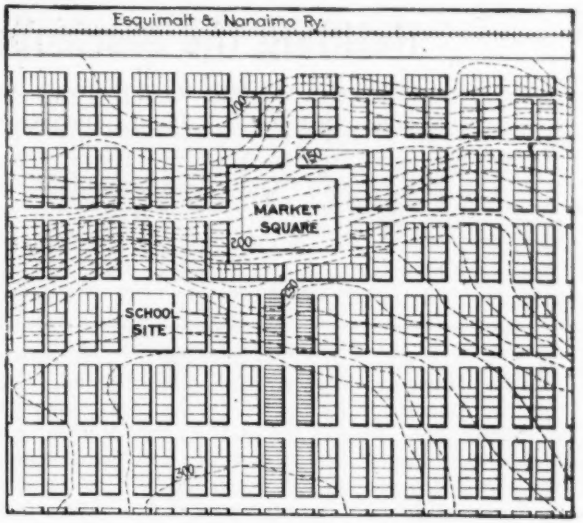


FIG. 2. CITY PLAN ADOPTED ARBITRARILY: LADYSMITH, B. C.
(Blocks, 360 x 260 ft.; streets, 80 ft.; contours, 10 ft.)

center, the grade of the center line on the short axis being 14 per cent and the street leading to it from the railway station having an average grade of 7 per cent. In fact the square is not used for business.

The subdivision of large lots into small ones on the central street is a modification of the original plan, but is witness to the fact that excessive street area tends to force the creation of narrow frontage lots. As there are no building-line restrictions, the tendency throughout has been the usual one of building as close to the frontage line as possible, so that in spite of the wide streets the general effect is that of overcrowding.

Economics of Street Widths—When a town has excessive street area in proportion to building area, the usual result is that street construction is temporary, with dirty roadways and dangerous ditches and sidewalks. If the citizens are determined to have improved roadways, with sidewalks and drainage, the burden of taxation may be out of all proportion to the value of the property benefited. In some cities this heavy taxation for street improvements has made it impossible for owners of vacant property to retain their holdings. Then the property has been allowed to go to tax sale, with the consequence that the holders of improved property have to carry an increased burden, and educational and social programs have been crippled because of excessive taxation for what are termed "local improvements."

DISTRIBUTION OF AREA IN CITY PLANS

	Loveland		Ladysmith	
	Acres	Per Cent	Acres	Per Cent
Building area	156	71	114.5	52.00
Park area	11	5	6.0	2.75
Street area	53	24	99.5	45.25
Total	220	100	220.00	100.00

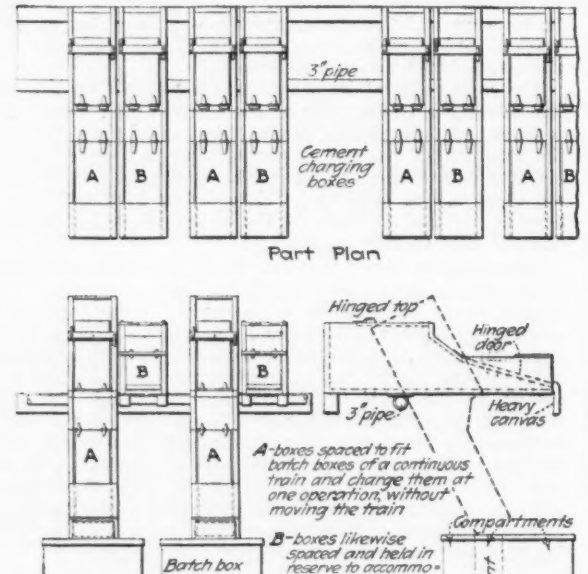
Excessive street area also adds to the cost of building land. If 20 per cent of the total area of land in a subdivision is devoted to streets, 25 per cent must be added to the original price of the land to make up for the loss of land not saleable. With 25 per cent in street area, 33 per cent must be added. It is thus common to find subdivisions with very wide streets having very narrow frontage lots, resulting in lateral overcrowding, which far outweighs any advantage that may result through the separation of buildings by the wide streets. To offset the high cost of land and street construction, the character of the building suffers, rooms being cramped or the sanitary essentials of a home sacrificed. It is not uncommon in such cases to find that more has been spent on the land and its development than on the buildings which are placed on the land.

Building the Maricopa County Concrete Roads

Field Methods Used in 141-Mile Road Contract Around Phoenix, Ariz. — Handling Cement, Operating Central Distributing Plant, Dispatching Material Trains, Scheduling Night Work

In the May 26, 1921, issue, p. 882, there was an article setting forth the outstanding features of the road program at Maricopa County, Ariz., where 141 miles of concrete paving is being placed under one contract and where over $8,000,000 has been voted for a 309-mile program. The job has recently been visited by a member of the editorial staff of this journal, as a result of which the following details of the construction operations have been prepared. The article should be read in connection with the earlier one noted.

THE sand and gravel washing plant which supplies the Maricopa County road job with aggregate for the concrete is located at Tempe, Ariz., about 10 miles from the center of the paving network under construction. It consists of two complete units which can be operated independently but which are built in the same timber structure. These units are exact duplicates even to having interchangeable parts, so as to reduce the danger of a complete shutdown of the plant. Rearrangement and additions to the washing system have been made



DETAIL OF DEVICE FOR CHARGING BATCH BOXES WITH CEMENT

from time to time in order to secure as many washings as possible.

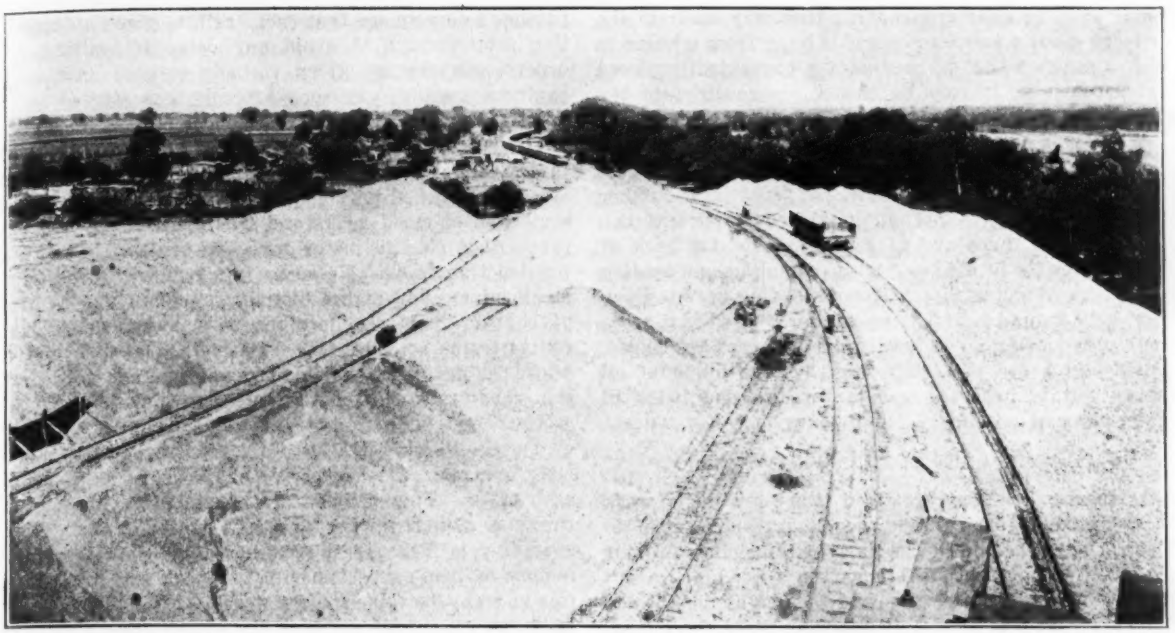
As now operated, streams of water are directed against the incoming material (1) at the top of the bucket elevator whence the sand is washed through a sluice box to a screw conveyor, (2) in a series of streams on the inclined screw conveyor, (3) on the inside and (4) on top of the revolving screens where the rock is graded.

The efficiency of this washing system is high and it is claimed that only a negligible quantity of fines are left in the sand. Both the rock which goes through the crusher and the finer gravel consist largely of gneiss, quartzite and granite which have been worn down by river action until only the very hardest parts remain, thus affording materials of an exceptionally high grade. The proportioning of these materials has been worked out in accordance with the Abrams theory to obtain the maximum density and strength of concrete.

The plan is to have the washing plant keep about 10,000 cu.yd. of graded crushed rock in bunkers or storage piles ready for delivery. A minimum limit on sand has been unnecessary because thus far the material taken from the river bed has always produced 10 to 15 per cent more sand than gravel. In fact, if the present proportion continues the ultimate disposal of the sand surplus accumulating at the washing plant may become a problem. Sand and gravel are stored chiefly in piles near the plant whence a grab bucket operated by a locomotive crane loads the material into gondola cars. About 25,000 cu.yd. of sand and gravel were stored in bunkers and piles at the plant on May 11 and only one 8-hr. shift was working. When necessary the plant is operated two or three 8-hr. shifts daily until the desired storage is secured.

District Distributing Plant.—As first laid out the Maricopa County road system was planned for construction from three district distributing plants, work was to be carried on simultaneously at two while the third was being dismantled and set up at a new location. Construction began with two such plants in operation, one at Chandler and one at Fowler. Before the third plant had been built it was decided that greater economy and probably the same rate of progress, in the long run, could be made by working from only one distributing plant. The plant at Chandler was therefore shut down temporarily, and men and equipment were concentrated on that portion of the work that could be reached from Fowler. The third plant has not been built and will not be needed under the present program.

This rearrangement of the program did not radically change either the field forces, the number of mixers served or methods of handling materials, it merely routed materials through one central plant instead of two, and somewhat increased the length of maximum haul. With a maximum haul of 7 to 9 mi. it is believed that three locations for the distributing plants can serve advantageously the 150 mi. (approximately) of pavement which the bonds already sold ($4,000,000) will pay for. When some 22 miles more of pavement have been laid from the present plant at Fowler (this was written on May 11) men and equipment will be moved to Chandler to complete the work centering in that locality while the Fowler plant is being moved to Glendale, probably the last location under the present contract.



25,000-CU.YD. STORAGE PILES AT TEMPE CENTRAL MATERIALS PLANT
Sand piles at left and gravel at right

Materials from the washing plant are delivered in standard-gage trainloads to the district distributing plant. There a 4 per cent incline takes the cars onto a trestle whence they dump into the sand and gravel bunkers. Carloads of cement are taken up on the same trestle and by means of chutes from the car doors through openings in the roof of a cement house alongside, sacked cement is delivered by gravity direct to storage piles at a level above the industrial track on which materials are distributed.

The district distributing plant for aggregate and cement was shown in a sketch in the article in the issue of May 26. It is arranged for simultaneous loading of 12 cars which constitute a train, each car carrying two 4-sack batch boxes. Details of the cement charging boxes are shown in the drawing on p. 1026. In the cement storehouse the sacks are emptied into dump boxes balanced on a 3-in. pipe and so located above the track that when tilted down the cement runs through a closed section or spout into the cement compartment of batch boxes. The cover on the lower or chute portion of each dump box is hinged at its upper end so that it rests on the cement, thus eliminating an air space but swinging away freely when full opening for free passage of the cement is required. A piece of canvas or cement sack attached to the lower end of each spout serves as a curtain covering the batch box compartment into which the spout delivers. These two features were introduced to reduce the loss and nuisance occasioned by the escape of cement dust.

The air suction method of unloading bulk cement, which was used at first, had to be taken out of service frequently for repairs, the most persistently troublesome item being the excessive wear on the air locks or valves, caused, it is thought, by unground clinker in the cement. This clinker amounted to less than one-half of 1 per cent but this percentage was in large grains which scored the metal of the locks so that the vacuum could not be maintained. The suction unloader was altered several times and latterly a different air lock arrangement was tried. Meantime, to insure continuity of service, means for handling cement in sacks had to be maintained. Finally, decision was made to use sacked cement exclusively, and the suction unloader was taken out of service pending further development of the equipment.

Both sand and gravel bunkers deliver through chutes provided with an automatic cut-off or combination door and spout. This is a steel plate with edges curved upward, which is attached to the chute by a spring so that it can be sprung from closed to open position under pressure of the hand. Baffle boards of 1-in. lumber made up in sections about 12 ft. long and hinged longitudinally to the trestle timbers along the track are used to prevent the wasting of material from the spouts as the cars are being loaded. These baffles are hung so so that when swung on their hinges in toward the track they extend from the trestle timbers to the edge of the cars on a slope of about 45 degrees. When the spring gate is wide open there is no spillage, but during the short interval of opening or closing, the stream of material is directed over the edge of the car. When ready to either close or open the gate, the operator raises a baffle board section with one hand, thus catching the momentarily deflected stream and turning it into the proper compartment in the car. The batch boxes are placed on the cars with all sand compartments on one side and gravel compartments on the other. The spouts from the sand bunkers incline toward one side of the track and gravel spout to the other. Baffle boards are used only on the side of the track toward which the delivery spouts incline.

When the compartments do not fill evenly, the operator closes the gate to stop the flow of materials for a moment and using a small piece of board as a pusher, which he carries for this purpose, levels off the material in the car. The use of this pusher-board has been insisted upon to insure accurate measurement of

materials. To clear any choking that may occur in the delivery spout a wooden plunger is hung from a hinge in such a position that by means of a conveniently placed wooden handle, it may be thrust vigorously into the chute.

When it is necessary to speed up train movements, all the sand compartments of a train can be loaded simultaneously and, with a single additional "spotting," further down the loading tunnel, all gravel compartments can be filled. As there are 24 compartments for each of these materials in a 12-car train, simultaneous loading of all cars would require a 12-man loading crew. However, only four to six men are ordinarily used in a crew, these men moving down the train as the cars are loaded. An inspector for the county watches the filling of all trains and is held responsible for the quantities of materials sent out in the batch-boxes.

Labor Schedule and Night Work

As the work is now arranged two 8-hr. shifts work on the mixer crews; 7 a.m. to 4 p.m. and 6 p.m. to 2 a.m. The schedule of the day shift includes an hour for lunch. The night shift is served a hot lunch about 10 p.m. but the men eat this in relays so as not to stop the work. At the district distributing plant three 8-hr. shifts are necessary to keep just a little ahead of requirements. The "grave-yard shift" uses only about 13 men as compared to the 18 men used on the other two, and in addition to filling and delivering to all the mixers one or more trains of material, it does all necessary cleaning up around the plant and any rearranging or repairing that would interfere with routine operation during the day. At first this shift only filled the cars and left the trains to be delivered first thing in the morning. This plan was given up in favor of immediate delivery to avoid the delays that might result from a blockade or other failure of the transportation system before the morning deliveries had been made.

After daylight hours each paving unit is lighted by acetylene lights of which about seven are used at each mixer. One of these is set to direct its light where it will be of most benefit to the men engaged in making the batch transfer, one is set to illuminate mixer operation, one for the special use of the men working with the finishing machine and the others are distributed along the sides of the roadway, wherever needed.

The mixer crews and all the men whose work has a direct bearing on the rate of progress in laying pavement, have an opportunity to earn a bonus. A bonus of 10 per cent of each man's wage is paid for every 50 ft. of pavement laid per day beyond the footage set as a standard. Effort is made to fix this standard with respect to the various conditions affecting each part of the job so as to give all an equal chance. As much as 30 per cent bonus has been earned on this basis at times. This makes a real inducement for teamwork and speed even in the case of common labor which is paid $3.85 per 8 hours.

Train Dispatching System.—After some experiments with telephone and other control systems, the best plan of dispatching concrete trains from the district distributing plant to the several mixers was found to be to eliminate all signal or train order methods and put the entire control of the train movements in the hands of a dispatcher equipped with a motor cycle. The locomotive engineers have standing orders to "hit the track" as soon as their trains are ready. It is the train dispatcher's duty to see that each train is given a destination soon enough to avoid any delay in waiting for orders. Orders are given verbally to each locomotive engineer usually very soon after he has started away from the central distributing plant.

The success of this method is due largely to the fact that for most of its length the construction railroad lies alongside finished pavement. All parts of the work are accessible on good roads and where necessary the dispatcher can ride his motor cycle between the rails of the construction track. He keeps in touch with conditions at all mixers and at the distributing plant and in case of shut-downs, train derailments or other delays, reroutes trains accordingly. This method of dispatching affords a flexibility which makes it possible to adjust the schedules to suit contingencies as they arise.

The dispatcher expects trains to make 6 miles per hour or more. Passing tracks are located every half mile. Only one man, the locomotive engineer, is assigned to each train. This man rarely has to leave his cab to throw a switch at the far end of the train. Such switching is infrequently required and when necessary is done by men connected with the work who are riding to and from the mixers a great deal of the time. Under ordinary conditions it takes the mixer crew about 40 minutes to use up a 12-car trainload of material.

With three mixer plants in operation and hauls from the central distributing plant of 2, 5 and 6½ miles respectively, which happened to be the situation when the job was visited recently, 14 gasoline locomotives were in use. Of these two were kept in reserve as spares, one was used for switching at the central plant and 11 were employed in actually making the train movements required. The requirements vary from two to four locomotives per mixer, according to the distance from the central distributing plant.

Repairing Facilities

Derailments due to broken axles have been more frequent than any other transportation trouble. The explanation of this offered by engineers on the work is that only axles containing an inferior grade of material have been available of late. Axles have been purchased from different factories without changing this condition.

Each locomotive carries re-railing frogs with which a derailed car in favorable position can be run back onto the track very quickly. The track itself, which is of 24-in. gage, is reported to have given no trouble whatever. It is laid in 15-ft. sections, has 20-lb. rails bolted to pressed steel ties with edges curved down all around to grip the roadbed. Adjoining sections are connected only by the slip joint at the end of each section, no bolt being used to fasten the sections together. The track is not kept in particularly good alignment, nor is the roadbed given much attention, yet even in collisions violent enough to buckle the steel frames of the car trucks, the track has not been shifted materially nor shown the need of special attention or more care in maintenance.

Four mixers are set up in the field for service from the district distributing plant, but crews are supplied for only three, the idea being to keep one in reserve so when a breakdown occurs the crew can go immediately to another mixer without loss of time. A fifth machine has recently been assigned to the Fowler plant to serve as a spare so there will be better opportunity to always maintain four mixer plants in the field.

Handling and Finishing Concrete.—The concrete is mixed in 4-sack batches in a 3-sack mixer. This causes some spillage and overflow, particularly in delivery from mixer to skip. As this overflow is on the subgrade and is covered in a very few minutes, it is not considered objectionable. The mix is placed as dry as is believed to be consistent with the elimination of air pockets. Maintenance work on the mixer has been simplified by keeping well greased all parts where spillage of concrete might occur. The oil used for this purpose is that drained from crank cases of gasoline engines used on the job. The steel header boards are also well greased with the same material just ahead of the mixer. A concrete spade is used vigorously in the concrete along each header board to insure the elimination of all "rat holes" and air pockets along the edge. On at least one of the mixing outfits, a weight of several hundred pounds has been added to the tamping machine to steady its operation and reduce the vibration. The operation of this machine is reported to be more satisfactory since it was weighted.

The finishing done by the belt attached to the tamping machine is supplemented by a hand-operated belting machine which is kept well back of the tamper. This second belting is done as late as consistent with the initial set of the cement and is regarded as an effective means of avoiding the tendency to form hair cracks. No hand roller is used in finishing the pavement; the mix is kept rather dry and, in a moisture-absorbing atmosphere, by the time the last belting is completed it is believed there would not be enough water in the surface to permit of the use of the roller. The use of a float is forbidden in the specifications, but its use is tolerated because it has been found desirable to have some means of smoothing up the surface here and there where the second belting has disturbed small rocks near the surface, smoothing out dog tracks in the fresh concrete, etc. An iron edging tool is used to round off the corner of the slab on a 1½-in. radius. This avoids the sharp corner or feather edge in the concrete at the header board. It is not expected that this pavement will later be widened.

A device which has been found particularly useful to the mixer crew is a tool-car built to run on the header boards as rails and which has a box for carrying supplies and miscellaneous spare parts for the mixer. This tool car is pushed ahead of the mixer and has frequently saved the delays incidental to going back to to the nearest base or sending a messenger for the parts and supplies necessary to make minor repairs.

Quick Setting Cement

Under weather conditions obtaining on this work the cement ordinarily takes its initial set about an hour quicker than at the cement mill in Riverside. In addition to this, when using water whose temperature is 100 deg. F., which is frequently the case during the summer weather when the water comes from a pipe laid on top of the ground, the cement sets an hour quicker that when water at 70 deg. is used. Thus during the hot weather this season, it is planned to ask the mill for cement with 4-hr. initial set in order that the desired condition of a 2-hr. initial set may be obtained on the work.

A comprehensive study is being undertaken to determine how and to what extent water temperature affects the rate of setting under conditions as they obtain on this work. In making the initial set tests on each car of cement, the practice is now to make these tests both with water at 100 deg. F. and at 70 deg. F., as it has been found that the former gives quicker results which check very closely with those made in the usual way. The 70-deg. tests are continued as a check.

Every precaution is taken to get water on the finished surface as soon as possible. Occasionally in order to flood it before the surface has hardened sufficiently to permit of shoveling earth upon it, dikes are built up along the headers and a transverse check of fines is carefully thrown across the pavement and the reservoir thus formed is filled with water. By the use of sand from which "fines" have been eliminated, late belting, and early flooding of the pavement, it has been possible to prevent the formation of hair cracks engineers on the work affirm, so the use of a burlap cover or sun shield, mentioned in the description of this work referred to at the beginning of this article, has not been found necessary and was discontinued.

Expansion Joints

Each shift places two expansion joints clear across the road. That is, they average one for every 4 hours' work of the mixer crew. At the outset these were made of an asphaltic compound ½ in. thick. In about 35 mi. of pavement laid in cold weather, expansion of the concrete closed the ½-in. joints, crushing the concrete and occasionally slightly buckling the slabs at a point. This movement of the pavement was ordinarily carried through several expansion joints and caused the buckling only at intervals of about a half-mile. Thus far the buckled pavement has always returned to its original position when the temperature lowered.

Some of the movements raised both of the abutting slabs but more often one slab was thrust up over the edge of the one adjoining. Where both slabs rose the danger was found to be in longitudinal cracks caused by heavy vehicles on the unsupported pavement; where only one slab rose there was a sharp-cornered ridge across the pavement sometimes 2 in. high, as well as occasional scaling off of the surface where excessive pressure was concentrated near the top of the slab. It is believed that while the paving laid in hot weather will not crush the ½-in. joints, it may shrink and cause contraction cracks in cold-weather. In order to correct the tendency to buckle in the cold-weather pavement, transverse cuts are being made near the joint where the buckling occurred and one or more additional expansion joints are inserted there. These cuts are made 10 to 15 ft. back of the joint to catch any longitudinal cracks that might have occurred while the slab was raised.

The width of construction joints is now being determined in the field by the engineer in charge of the paving units according to a table which gives the width of joint considered proper for every 10 deg. F. variation in temperature of the mixed concrete. On this work the maximum temperature of the pavement, due to direct rays of the sun, was taken to be 140 deg. F. and the minimum temperature 20 deg. F., giving a total variation of 120 deg. F. With construction joints placed every four hours the average slab length is 250 ft. The average width of the construction joints is 1¼ in. A maximum of 1½ in. is used.

The work is being done for Maricopa County under the general supervision of R. C. Perkins, county highway engineer. Twohy Brothers, for whom John F. Horan is engineer in charge, hold the contract for that part of the work to be done under the first bond issue.

Earth Fill Irrigation Dam Has Some Novel Details

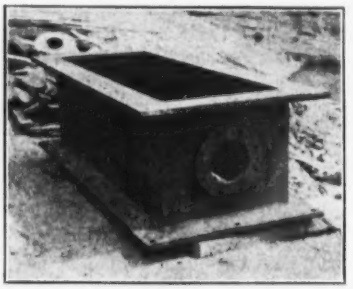
Loose Rock Drains Lower Saturation Line—Air Vents Added to Sluiceways Permit Trapped Air To Escape

By Clair V. Mann
Civil Engineer, Rolla, Mo.

SOME of the details of the Apishapa Dam, recently completed near Fowler, Col., by the Apishapa Consolidated Irrigation Co., are sufficiently novel to make a record of its design worth while.

The dam, the completion of which is a triumph of enterprise for the small group of farmers who make up the irrigation company, is designed to form a storage reservoir of 26,000 acre-feet capacity to supplement the natural stream flow of Apishapa River, and thus irrigate 20,000 acres of fertile land in the famous Arkansas Valley region of Colorado. Irrigation from natural stream flow without storage had been carried on for some twenty years, but had proved inadequate for growing of successful crops. Storage from the dam will make this project the equal of any in the valley.

It is built across the bottom of the 200-ft. rock-walled canyon of Apishapa River, and consists essentially of a 318,000-cu.yd. earth embankment reinforced on the lower toe by a 11,000-cu.yd. rock fill toe. The water face is surfaced with broken stone riprap laid on a 6-in. crushed-rock cushion. Across the canyon, the dam is 586 ft. long on top and 300 ft. at the bottom. The dam crest as planned is 19.35 ft. wide over all, and the base of dam at maximum section is 594 ft. wide. As planned, the height above river bed is 120 ft., and this is 152 ft. above bedrock and bottom of cutoff wall. It is also 16 ft. above crest of spillway, which consists of a natural saddle one mile from the dam, large enough to pass any flood that may ever occur.

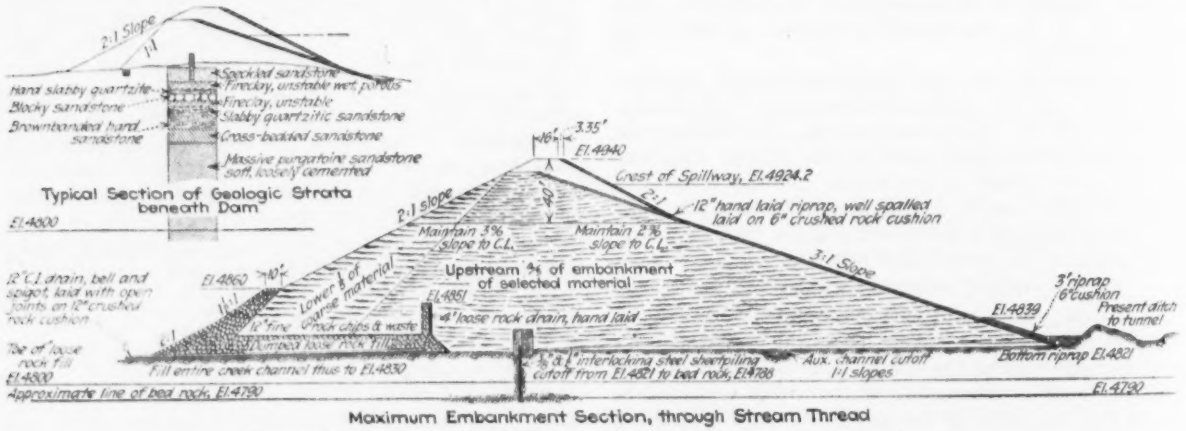


SECTION OF CAST-IRON SLUICEWAY SHOWING AIR VENT

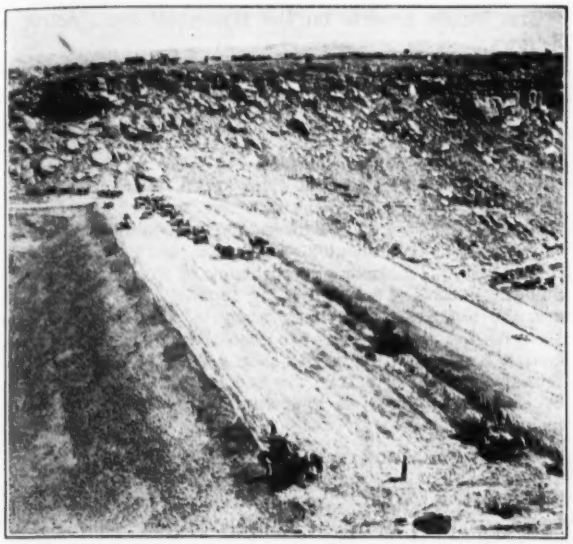
The crest of dam as built is only 7.8 ft. above spillway crest, and the writer considers this insufficient margin for safety. Financial considerations led to the decision to restrict its height as indicated.

Both embankment slopes are 2:1 for the top 40 ft. of the section. From this point to base, the water slope is 3:1. The downstream face is 2:1 to a point 80 ft. below crest, where a 10-ft. horizontal berm is introduced at top of rock-fill toe. From the foot of the 2:1 slope at the inner edge of this berm, the earth fill continues to its base on a 1:1 slope against which the rock-fill toe rests. From the outer edge of the berm, the slope of rock fill is 1½:1 for 30 ft. vertically, at which point its slope meets the original 2:1 slope from top of dam, which then continues to base of dam. The embankment built in 12-in. layers, placed in windrows across the canyon by means of dump wagons. Each layer was spread with a blade grader, sprinkled, and rolled twice with a corrugated wheeled roller weighing 250 lb. per lineal inch of tread. Successive layers were pitched toward center of dam 3 per cent from downstream and 2 per cent from upstream slopes.

The canyon is cut down through the massive Dakota sandstone and the alternating shale, clay, and sandstone beds under it to the massive, Purgatoire sandstone at the base of the Dakota formation. The canyon bottom at the dam site is covered with 50 ft. of intermixed adobe clay, fine river sand, and gravel, with an occasional boulder. The original plans contemplated a concrete cutoff wall extending down to bedrock, and up from stream bed a height of 50 ft. The construction of this wall would not have been within the company's means, so that a steel sheet-piling wall of ¾ in. and ½ in. thickness, Carnegie and Lackawanna sections, was substituted. This wall is 8,000 sq.ft. in extent, and extends from 1 ft. above river bed to bedrock, or 33 ft. in depth. It is supplemented by a double-plank wall 12 ft. high, bolted to the top of the steel wall, the joint being made water-tight with concrete. Both steel and wood walls are joined to the sides of the canyon by means of concrete walls built into notches in the faces of the cliffs, which walls extend down to bedrock and also encase each end of the steel and wood walls. By an extension of these walls up the cliff faces and out 10 ft. from them, a comparatively water-tight joint is made between earth embankment and


2:1 Slope
Hard slabby quartzite
Blocky sandstone
Brownbanded hard sandstone
Speckled sandstone
Fireclay, unstable wet pockets
Fireclay, unstable
Slabby quartzitic sandstone
Cross-bedded sandstone
Massive purgatoire sandstone soft, loosely cemented
Typical Section of Geologic Strata beneath Dam
El 4800
12" C.I. drain, bell and spigot, laid with open joints on 12" crushed rock cushion
Toe of loose rock fill El 4800
Approximate line of bed rock, El 4790
El 4860
Lower ½ of coarse material
6" fine rock chips & waste
Compact loose rock fill
Fill entire creek channel thus to El 4830
Upstream ½ of embankment of selected material
El 4851
4" loose rock drain, hand laid
⅜" x 6' interlocking steel sheetpiling cutoff from El 4821 to bed rock, El 4788
Aux. channel cutoff 1:1 slopes
Bottom riprap El 4821
El 4790
3:1 Slope
3' riprap 6' cushion
Present ditch to tunnel
El 4839
Maintain 3% slope to C.L.
Maintain 2% slope to C.L.
16'
3.35'
El 4940
Crest of Spillway, El 4924.2
12" hand laid riprap, well spalled laid on 6" crushed rock cushion
Maximum Embankment Section, through Stream Thread

CROSS-SECTION AND SUB-SURFACE CONDITIONS AT APISHAPA DAM



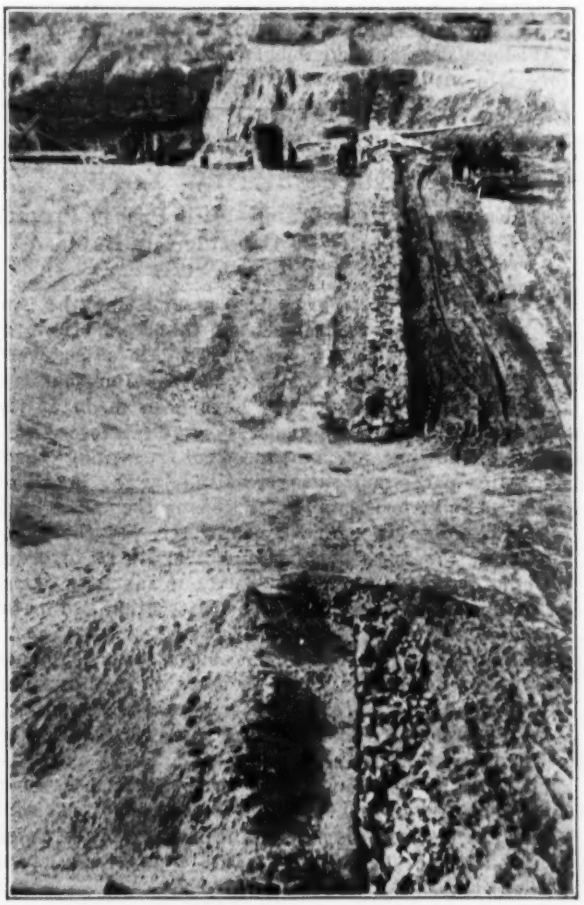
APISHAPA DAM NEARING COMPLETION

cliffs, and to this end the earth placed next to the walls was thoroughly puddled.

A novel feature is the construction of loose rock drains within the lower half of the embankment. This is designed to lower the line of saturation, and together with the rock-fill toe, will prevent the slipping off of the lower toe. The construction of the drains started with laying a 12-in. cast-iron pipe in the old stream bed, beginning 60 ft. downstream from axis of dam, running thence out beyond lower toe of dam. This pipe was surrounded with rock chips and crushed rock, and to it, at upper end, were joined two 8-in. cast pipes extending across the canyon to the cliffs, and up them through a notch. From the tops of the cliffs, clay tile instead of cast iron is used. Over all the pipes so laid and protected with crushed rock, a loose rock fill was placed to a depth of 10 ft. in the old stream bed and downstream from the 8-in. cross pipes. Directly over the 8-in. pipes a wall from cliff to cliff was built to a height of 30 ft. above the old stream bed and 4 ft. thick. This was constructed as an integral part of the earth embankment, and was covered on each side and over top with 1 ft. of loose rock chips and fine rock-waste to prevent entrance of earth fill. From the top of this wall, at its ends, the loose rock fill over the pipes was continued up the cliff faces and from them upward toward the ends of the dam, the section here being 4 x 4 ft., with waste covering additional. An accompanying view shows the cross-wall drain being built into the earth embankment.

The outlet is through a tunnel 10 x 10.75 ft. finished size, bored through the solid rock at one end of the dam. This tunnel was required to pass 2,000 sec.-ft. of water for prior rights down the river, so that portions of it passing through soft rock and shale pockets had to be concrete lined. The tunnel is approximately 700 ft. long. The cliff over its entrance was made vertical, and into it 20 ft. above river bed a chamber 12.5 ft. high, 37 ft. wide, was driven a distance of 17 ft. The inner 11 ft. was then sunk to the level of the tunnel and river bed. The inlet chamber was divided into five compartments by means of concrete piers and partitions, and the trash rack bars set on the chamber face in the plane of the vertical cliff. A scour gate was set at the level of the river bed and tunnel floor. Water entering the inlet pours over the inner edge of the inlet chamber floor and drops to the tunnel floor 20 ft. below. This arrangement was made to allow the silt to seal the reservoir floor in front of the dam, thus preventing seepage.

The outflow is controlled by two 42 x 72-in. and one 24 x 72-in. rectangular sluice gates installed in the tunnel 208 ft. from the head of inlet chamber. The gates are of very heavy, bronze-mounted pattern, designed to operate under 100 ft. head. The two larger gates are hydraulically operated. The smaller gate has a steel stem rising to the top of a gate tower built over the smaller gate. Hand-operating mechanisms



DRAIN WALL ACROSS CANYON CONSTRUCTED AS PART OF EARTH EMBANKMENT

and the oil tanks and pump are installed on the gate-house floor. The gates are placed at an angle in the tunnel, which at this point is enlarged to a finish width of 20.5 ft. The gates are set on the upper ends of three cast-iron sluiceways each 12 ft. long, 6 ft. high, and equal in width to the respective gates. These sluiceways discharge into a curved, concrete-lined chamber which connects with an 80-ft. section of concrete-lined tunnel.

To overcome the difficulties elsewhere experienced with gates of this type where set on concrete walls and sluices, an air-vent system was added to the cast-iron sluiceways. Eight-inch pipes enter each of the sluiceways at the top and just behind the gates, and

from thence are led to a vertical steel air pipe which extends up inside the gate tower to a point above high water and there passes through tower wall horizontally. An auxiliary outlet well 4 x 4 ft. in section rises from the lower end of the gate chamber just outside the gate tower, and to within 25 ft. of high-water line where a 30-in. gate valve controls the outflow through this well. A connection between this well and the air-vent pipe will permit any air trapped in the tunnel to rise and escape whenever the well itself is not discharging.

Two sets of plans were drawn up and abandoned before the final plans, prepared by the writer, were made up and the dam constructed. The writer was engineer in charge during construction and A. J. McCune, State Engineer of Colorado, was consulting engineer.

[A telegram from Mr. Mann dated June 9 says "Apishapa dam outside Pueblo cloudburst area, therefore safe with storage at El. 4865."—EDITOR.]

Recommend Concrete for Ocean Structures at New York

City Engineers Report That With Proper Precautions Reinforced Concrete Can Be Made Safe in Sea Water

THE City of New York is contemplating the construction of a boardwalk on the ocean front at Coney Island and at a more remote date a boulevard of the boardwalk type across a part of Jamaica Bay. Designs for these structures have been made of the usual pile and beam-and-girder type of reinforced concrete. Following an announcement regarding these structures a communication received by the Board of Estimate and Apportionment criticizing the use of reinforced concrete in or near sea water, led the Committee on Finance and Budget of the Board to order the chief engineer, Arthur S. Tuttle, to submit a report on the feasibility of this type of construction and material for sea-water exposure. Mr. Tuttle's report, including a detailed report by Kenneth Allen, engineer of the Board, has just been made public. It contains an extensive résumé of the literature of the subject, a symposium of opinions by various experts, and the conclusions of both Mr. Allen and Mr. Tuttle as to the availability of reinforced concrete for sea-water work. Briefly, both engineers are of the opinion that reinforced concrete may be safely used in or near sea water provided proper precautions as to type of structure methods and materials are taken.

The investigation was started by a criticism of Charles R. Ward, president of the Ward Engineering Corporation of Brooklyn, N. Y. Mr. Ward alleged that experiences with reinforced-concrete structures exposed to sea air and to sea water have demonstrated that salt water or salt air will penetrate the concrete, causing the steel reinforcement to rust and expand and the concrete to spall and crack, thereby gradually weakening the structure until it finally falls. In support of his contentions he quoted articles in *Engineering News-Record*, particularly those of March 25, 1920, and Jan. 20, 1921, describing the condition of reinforced-concrete pleasure piers on the Pacific Coast in southern California. He further refers to the dangerous condition of the reinforced-concrete municipal bath house at Coney Island, which is very near the proposed structure.

Mr. Tuttle reports on the municipal bath house as follows:

The municipal bath house at Coney Island is a reinforced concrete structure built in 1911, designed originally to have a position back of and immediately adjoining the mean high water mark. It rests on a series of reinforced-concrete beams, those extending transversely being 8 x 15 in., while those having a longitudinal direction are 8 x 13 in., except under the side walls, where they are 14 x 13 in.; these in turn are supported on reinforced-concrete columns, arranged in 20 bents spaced about 20 ft. c. to c., each bent generally consisting of 5 columns spaced about 16 ft. apart, the outer and center lines of columns being 16 x 16 in. in cross section and the two remaining lines being 14 x 14 in. The floor slabs resting on the beams are about 8 x 20 ft. The columns have a length of a little less than 9 ft., and rest on spread foundations which in turn are carried by wooden piles; the base of the columns is approximately at the elevation of mean high water.

CONDITION OF MUNICIPAL BATH HOUSE

The specifications for beams, girders and columns provide that: "The reinforcements of all beams and girders shall have at least 1½ in. of concrete protection at the soffits and sides. The vertical reinforcements of the columns shall have at least 2 in. of concrete protection and shall be firmly secured together with ¼-in. wire ties every foot in height."

An inspection made by Engineer Kenneth Allen and Assistant Engineer Leicester Durham of this office on March 16, 1921, shows that in the six outshore bents small vertical cracks appear quite generally in the columns. These are usually short and vary in width from hair cracks up to ⅛-in., but in the case of two of the columns corners have spalled off for lengths of about 2 ft., here exposing the steel reinforcement. In this portion of the structure pronounced longitudinal cracks appear in the beams and girders along their underside and on the sides near the bottom, in a few cases exposing the steel, while in several places where no spalling or cracking has occurred the diagonal reinforcement is visible. Toward the northerly portion of this section the cracks are less pronounced. Through the remainder of the foundation of the substructure, and more particularly in the northerly portion, spalling was pronounced in the floor slabs, this generally being confined to small areas directly under the steel reinforcing rods which were exposed. In all cases the steel where exposed was rusted.

An examination of the remainder of the building disclosed no evidence of failure due to weakness of the foundations or to deterioration of the concrete.

The concrete appeared to be of good quality but there was evidence that the reinforcement in the sub-structure had been placed nearer the surface than provided under the specifications, and that in some of the floor slabs the steel was practically at the surface, while in the case of the columns where spalling was most pronounced the cover over the rods was originally only about 1¼ in., and in another case where the concrete was sound a vertical reinforcing rod projects near the foot of the column. It was the opinion of these engineers that there was no danger of the structure failing in the near future but that steps should be taken toward the necessary repairs at an opportune time. A later visit which I made to the structure confirmed the conclusions which had been reported by them.

A sample of the concrete used for the columns, which was tested in our laboratory, after thorough drying followed by 96 hours' immersion, showed a gain in weight of about 3.7 per cent, representing a porosity of about 9 per cent.

In my judgment, the damaged portions of the foundation can be satisfactorily repaired by stripping off all spalls or damaged concrete, cleaning the steel reinforcement where it can be reached, and sand-blasting the floor slabs, after which a thickness of from 1 in. to 1½ in. gunite can be applied to the columns, girders and beams over and above the amount required to restore the original sections, and a thickness of ¾-in. to 1-in. to the floor slabs. The cost of this work, including the wire mesh with which the girders,

beams and columns should be wound before the gunite is applied, if limited to the sections where cracking or spalling has developed, would probably not exceed $5,000, while, if the same treatment is extended to the entire foundation, the expenditure would be a little less than double this amount.

I am informed that since the building was placed in commission no work has been done in the way of repairs to the portions of the structure to which criticism has been directed, and the small expenditure now required certainly does not represent a serious outlay when the exposed position of the building is considered.

Conclusions by Engineers

Mr. Tuttle then quotes several experts who feel that such failures as have occurred in reinforced concrete in sea water are due to poor material and methods, and says: "From the investigations made by Mr. Allen it would appear that reinforced concrete may be safely used in or near sea water provided that the following conditions are complied with: (1) Proper materials, mixing, workmanship, curing and handling must be rigidly insisted upon; (2) the surface of the concrete must be protected from abrasion; (3) the steel reinforcement in that portion of the structure above mean low water must be given a cover of at least 3 in. of concrete. . . . I see no reason why a'l of these requirements cannot be adequately met in the construction of the boardwalk and am of the opinion that this type of construction is best adapted to the service required."

He suggests further that an experiment proposed by the chemist of the Board, William P. Carpenter, be made. Mr. Carpenter suggests an investigation of the effect upon the bond between steel and concrete of a coating of a grout of 90 per cent portland cement and 10 per cent zinc yellow (a chromate paint pigment). He thinks that if this test proves satisfactory such coatings should be required on the reinforcement in the new work.

Mr. Allen's investigations include a number of interviews with engineers who nave built or observed reinforced-concrete structures in sea water. These interviews give widely divergent opinions, though in the main the engineers are optimistic to the extent that they believe that if proper methods and materials are used reinforced concrete will be safe in sea water. A number of them, however, cite many instances of reinforced-concrete pile structures which are in various stages of deterioration. These observations relate almost exclusively to slender pile frames of long, unbraced length, where the structure is subjected to the heavy battering of waves and to extreme vibration: such a situation as is common for the usual pleasure pier or boardwalk.

Mr. Allen's conclusions, briefly put, are as follows:

While there is a decided difference of opinion as to the reliability of concrete and especially reinforced concrete exposed to sea water, it seems to be acknowledged that the concrete must be of the best and the steel should be practically inacessible to the infiltration of sea water. Otherwise, we have in the case of plain concrete disintegration due to chemical reactions, or in the case of reinforced concrete, failure due to either electrolysis (which is not common) or to rusting of the steel.

Whether the admission of moist air alone to the steel is a serious cause of failure is a matter of opinion, but the action is probably greatest when the steel is alternately wet and dry. Although we speak of the "salt air," it is questionable whether salt is ever really conveyed in the air except as spray.

Aside from theoretical considerations, the fact remains that there have been numerous failures of concrete, both plain and reinforced, in sea water, but particularly in reinforced work. Although the preponderance of opinion quoted expresses confidence in these materials, exhaustive inspections by Wight, Wig and Ferguson leave us with no doubt as to the general failure to secure permanent construction with these materials in America. I believe that if all the facts were known these failures could always be traced either to improper design, improper material, or improper workmanship. To secure dependable work practically 100 per cent excellence is required in all these elements and if, for industrial reasons or incompetency on the part of those responsible for the work, this cannot be assured, there will always be certain risks in using these materials. There is sufficient testimony that it is practicable to secure reliable work under favorable conditions, and in comparing results with timber or steel structures it is to be remembered that these, too, are subject to deterioration or failure depending on their design, material and erection.

To insure reliable results in reinforced concrete in sea water the following rules are suggested:

Rules for Securing Durable Work

1. Use some well-known portland cement of good character, with clean, hard, graded sand and gravel not over ¾ in. or 1 in. in size.
2. Mix 1 part cement to not over 4½ parts aggregate with just enough fresh water so that it will settle in place and envelop the reinforcing rods with light tamping.
3. Complete the placing of concrete in each pile or unit in one operation so that there will be no construction seams.
4. To secure a dense smooth skin some mineral oil should be applied to the forms. If practicable a richer mortar than the average and about 3 in. thick may be applied next the forms, keeping the larger pieces of aggregate away from the surface, but if this is done the mortar face should be placed at the same time as the rest of the concrete.
5. Reinforcing material above the level of low water should be placed at least 3 in. from the face of the concrete. Below low-water level a protection of 2-in. cover will suffice.
6. Allow the work to become thoroughly hard before permitting exposure to sea water. In the case of precast members this should be not less than 30 days.
7. In precast piles or similar members particular care is necessary to prevent injury by flexure in handling. If not maintained in a vertical position the exact location of supports to avoid undue stress should be stipulated and adhered to.
8. The application of a coating of gunite ¾ in. to 1½ in. in thickness on surfaces exposed to the extreme range of spring tides is strongly recommended as an additional precaution.
9. Piles placed in very deep water should be so braced laterally as to prevent injury by flexure.
10. If the structure is to be exposed to the impact of vessels or abrasion from ice it should be further protected by sheathing, fender piles or a heavily galvanized iron casing.

Assuming strict compliance with these rules it is the conviction that reinforced concrete may be safely used in marine works with assurance of a durability that will compare favorably with that of other materials ordinarily employed in such construction.

Road "Lighthouses" in Britain

The Ministry of Transport is experimenting with an occulting light which flashes every 15 or 30 sec., according to its adjustment. These lights are destined for two purposes: The first which will probably take the form of a red lamp, is to be placed at dangerous corners and cross roads. The second, which is to be white, will be arranged to flash on the new standardized road signposts, focussing its light on the figures at intervals of 15 sec. The lamp is small and compact, the flash being generated by acetylene.

Tests of Dredge Pump Operation for Hydraulic Fill

Velocities and Power Consumption Decrease as Friction Head and Solids Show Increase

By Ivan E. Houk
Assistant Engineer, Miami Conservancy District, Dayton, Ohio

IDEAL and actual operating conditions and their variations with the length of the delivery line are shown by the experiments at the Englewood dam by Professor S. M. Woodward, consulting engineer for the Miami Conservancy District, and the writer, in the summer of 1919. The observations also show the effects of variations in the character of the solids as well as the wide fluctuations in pumping characteristics which are continually occurring while handling large quantities of material. Briefly stated, the general conclusions which may be drawn from the tests are as follows:

1. The proportion of solids which may be safely carried decreases as the length of the delivery line increases.

2. In a 15-in. delivery line material is transported most efficiently at a velocity of about 12 ft. per second, the ideal velocity being the same regardless of the length of the line.

3. Wide fluctuations in vacuum, friction head, power consumption and velocity occur continually while pumping solids, even though the solids are fed to the pump as uniformly as possible. These fluctuations are caused by the unavoidable variations in the mixture being pumped.

4. During these fluctuations the velocity and power input to the motor decrease as the friction head and proportion of solids increase. The power consumption per cubic yard decreases with a decreasing velocity more rapidly than the total power input, since the increase in the proportion of solids causing the decrease in velocity more than compensates for the reduction in total discharge.

5. The friction head in the delivery line while pumping solids varies from one to several times the value for clear water, the actual amount for a constant velocity and a given material, increasing as the proportion of solids increases.

6. When the material being pumped is largely sand and gravel the friction head is considerably greater than when large proportions of clay and surface loam are being transported.

The original pump layout was in operation at the time the tests were made. (*Engineering News-Record*, Sept. 16, 1920, p. 547). Pumping units consisted of manganese steel dredge pumps having 15-in. suction and discharge openings and fitted with 46-in. impellers, direct connected to 500-hp. induction motors with variable speed control.

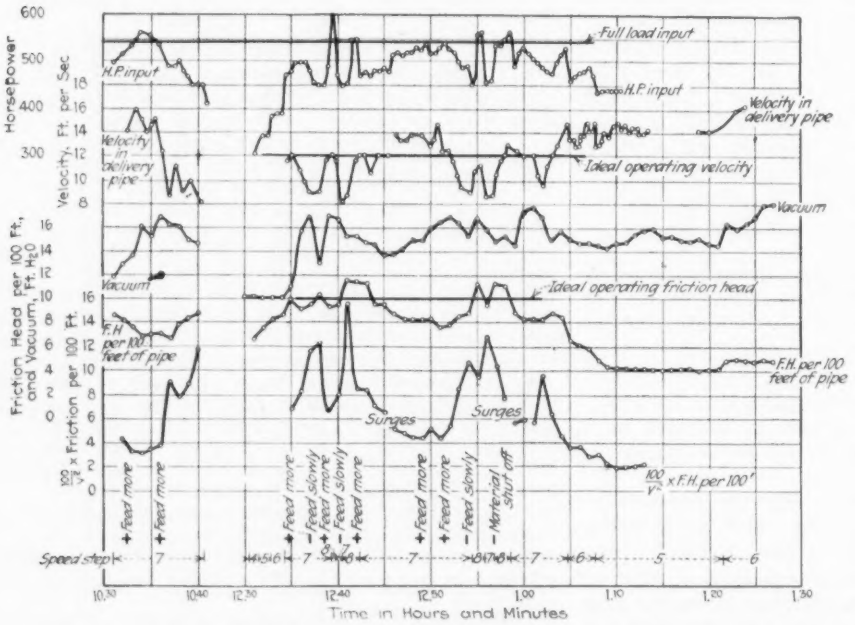


FIG. 1. OPERATION DIAGRAMS OF 15-IN. DREDGE PUMP, AUG. 28, 1919, WHILE DUMPING ABOUT 100 CU.YD. PER HOUR

(Static lift, 45 ft.; delivered line, 1,300 ft long, including 7 lengths of riveted pipe, 68 lengths of welded pipe, 113 ft. of standard wrought-iron pipe with bolted screw flange joints, one flap valve, one 90 deg. bend; diameter of pipe, 15 in. inside; diameter of impeller, 46 in.)

Tests were made on May 22, Aug. 28 and Sept. 5. On May 22 about 125 cu.yd. per hour of a mixture containing a large proportion of black surface loam was being pumped through a delivery line about 760 ft. long. The output on that date was limited primarily by the length of the delivery line and by the danger of plugging in a long sag across the pool on top of the dam, it being necessary, of course, to reserve a certain amount of power for use in emergencies. On Aug. 28 about 100 cu.ft. per hour of a mixture of sand, gravel and clay with a preponderance of sand and gravel, was being pumped through a line about 1,300 ft. long. On this date also, the primary limitation was the length and profile of the delivery line. On Sept. 5 about 190 cu.yd. per hour of a mixture similar to that handled on the preceding date, was being pumped through a line about 395 ft. long. During this test plenty of reserve power was available and the output was limited entirely by the amount of material that could be worked into the sump by the monitor man.

Velocities and friction heads in the delivery pipe were the only quantities measured on May 22. However, on the latter dates the observations were more comprehensive. On Aug. 28 continuous measurements of pressure, vacuum, electrical current, velocity, motor speed step and feeding signals were secured by a corps of trained observers, through a period of about an hour. Similar data were taken on Sept. 5, throughout a period of about 1½ hr., except that ammeter readings were omitted and, instead, a few scattered power measurements were secured by observing the speed of rotation of the disk on the watt-hour meter.

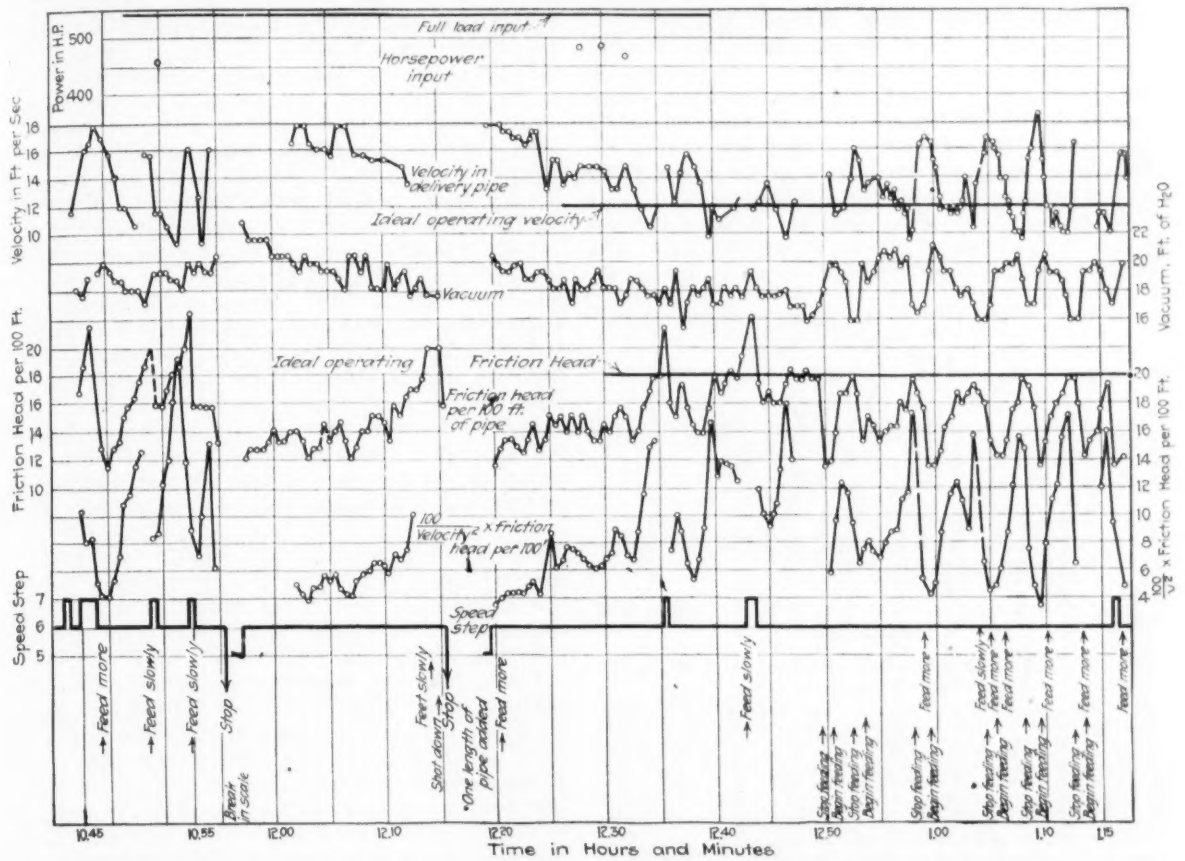


FIG. 2. OPERATION DIAGRAMS OF 15 IN. DREDGE PUMP, SEPT. 5, 1919, WHILE PUMPING ABOUT 190 CU.YD. PER HOUR

(Static lift, 49 ft.; delivery line, 395 ft. long, including 17 lengths of welded pipe, 1 length of riveted pipe, 102 ft. of standard wrought-iron pipe with bolted screw flange joints, one flap valve, and one 90-deg. bend; diameter of pipe, 15 in. inside; diameter of impeller, 46 in.)

Velocities were determined by measuring the curve of the jet at the end of the delivery pipe with the apparatus described in the *Engineering News-Record* of Jan. 6, 1920, p. 18. Since the vertical drop of the jet was kept constant and equal to 1.16 ft., the theoretical formula for reducing the observations would be

$$V = 3.72x$$

where V is the velocity in feet per second and x is the horizontal distance from the end of the pipe to the center of the disks. However, comparisons with pitot tube measurements, made while pumping clear water, showed that the coefficient should be raised to about 4.28, the pitot tube velocities being greater than those obtained from the jet measurements using the theoretical formula. In making these comparisons a rather crude pitot tube, made out of a piece of ½-in. pipe, was held at the center of the end of the delivery pipe, and the velocities obtained were reduced to mean pipe velocities by applying a coefficient of 0.9. Observations previously made with a standard Tulane tube on an 18-in. wood-stave line, carrying about 12 sec.-ft., showed this coefficient to be about 0.95. While the coefficient of 4.28 may be slightly in error it is believed that it is sufficiently accurate for the present purposes.

Results of the tests made on Aug. 28 and Sept. 5 are shown in Figs. 1 and 2, the various pumping characteristics being platted as ordinates against the times of observation as abscissas. Motor speed steps and feeding signals are shown just above the time scales. Feeding signals are self-explanatory. Speed steps were numbered consecutively from one to nine beginning with the slowest speed, number nine being the highest speed, 505 r.p.m. when full load is being carried. Detailed descriptions of pipe lines are noted under the diagrams.

The upper curve in Fig. 1 represents the horsepower consumed by the motor; that is, the power input, not the output. The rated output being 500 hp. and the efficiency 93 per cent, the rated input is, of course, about 540 hp. The horizontal line drawn on the figure at this value shows that the motor was operating at nearly full load the greater part of the time. The power curve was calculated from the ammeter readings using the relation determined from a comparison with the watt-hour meter when the motor was carrying full load. While the relation between power and current is not exactly constant, of course, where alternating current is being used, it was approximately so at the time the tests were made, owing to the comparatively small fluctuations in load.

The velocity curves show that the velocity varied from 8 to 16 ft. per second on Aug. 28, and from 9 to 18 ft. per second on Sept. 5. The fluctuations at a given motor speed were more pronounced as well as more frequent on the latter date when the proportion of solids was nearly doubled. This was also true in the case of the vacuum and friction heads, quantities varying somewhat synchronously in both tests.

The vacuum curves show the combined effect of changes in velocity head, entrance losses, and friction in the suction pipe, and in water level in the sump. On Aug. 28 the total vacuum head in feet of water varied from 10 to 18; on Sept. 5 it varied from 16 to 22. This comparatively high suction head was one of the undesirable features of the original pump layout which was remedied in the later installations.

The friction head curves show the actual variations in the friction head per 100 ft. of delivery pipe. The material being similar on these two dates, the variations were due entirely to variations in velocity and in proportion of solids. In an attempt to eliminate the effect of velocity changes the curve marked

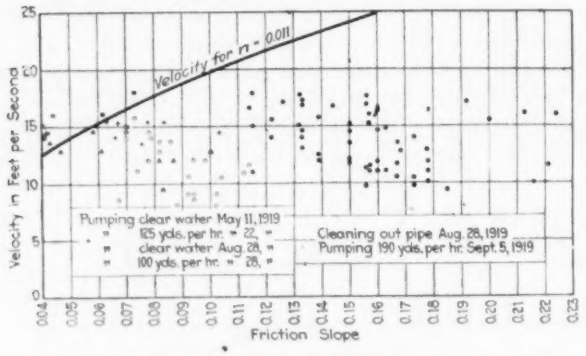

Velocity for n = 0.011
Velocity in Feet per Second
Friction Slope
Pumping clear water May 11, 1919
" 125 yds. per hr. " 22, "
" clear water Aug. 28, "
" 100 yds. per hr. " 28, "
Cleaning out pipe Aug. 28, 1919
Pumping 190 yds. per hr. Sept. 5, 1919

FIG. 3. DIAGRAM SHOWING FRICTION SLOPE AND VELOCITY IN DREDGE PIPE

(For descriptions of pipe lines on Aug. 28 and Sept. 5, 1919, see Figs. 1 and 2. On May 11, 1919, delivery line was 780 ft. long, including one flap valve, two 15-deg. bends, one long radius 90-deg. bend, 60 ft. of standard wrought-iron pipe, 20 lengths of riveted dredge pipe, and 26 lengths of welded dredge pipe. The alignment also contained some curvature made by a slight bending at consecutive pipe joints. On May 22, 1919, delivery line was 40 ft. long, including one flap valve, 75 ft. of standard wrought-iron pipe, one 15-deg. bend, one long radius 90-deg. bend, 20 lengths of riveted pipe and 21 lengths of welded pipe. The alignment also contained some curvature made by slight bending at the joints.)

$$\frac{100}{V^2} \times \text{F. H. per 100 ft.}$$

has been determined; in other words, this curve has been drawn to show what the friction head would have been if the velocity had been constant and equal to 10 ft. per second, assuming that the friction head varies as to the square of the velocity. This assumption, while practically correct for clear water, may, of course, be somewhat in error where solids are being carried.

It will be noticed that the irregularities in the curve of actual friction head are of less magnitude than those in the curve representing the friction head for a velocity of 10 ft. per second. This shows that the velocity decreases as the proportion of solids increases, thus keeping the friction head more nearly constant then it would be otherwise. This condition can easily be observed at any time by watching the jet at the end of the delivery pipe.

Fig. 1 shows that the actual power input to the motor increases or decreases as the velocity increases or decreases. However, the power consumption per cubic yard, which is the more pertinent quantity, decreases with a decreasing velocity more rapidly than the total motor input, since the increase in the proportion of solids accompanying the decreasing velocity more than compensates for the reduction in total discharge.

The ideal operating conditions are indicated on Figs. 1 and 2 by the horizontal lines cutting the velocity and friction head curves. On Fig. 1 the ideal friction head line has been placed at 16 ft. per 100 ft.; on Fig. 2 it has been placed at 18 ft. per 100 ft. The ideal velocity has been placed at 12 ft. per second on both diagrams. In other words, the velocity in the short line should be the same as in the long line while the proportion of solids should be higher. These lines represent approximately the conditions which the pump runners and monitor men try to maintain by the system of signals explained in *Engineering News-Record*, Sept. 16, 1920, p. 547. Actual velocities were generally below the ideal on Aug. 28 and above on Sept. 5; and the actual friction heads were generally lower than the ideal on both dates. The rather numerous signals shown in the lower right-hand corner of Fig. 2 were given by a somewhat panicky foreman, a bad plug having occurred a day or so before. He had been absent during the earlier part of the test; and better data would probably have been secured if he had been absent a little longer.

Fig. 1 shows that after the supply of material was shut off about seven minutes elapsed before the pipe was substantially free from material and about thirteen minutes before the friction was reduced to that corresponding to clear water.

Fig. 3, prepared by plotting velocities against actual friction slopes, shows in a somewhat different manner the great changes in friction head produced by variations in pumping mixture. The observations of May 22 and a few clear water observations made on May 11 have been shown in this figure, as well as the data taken on Aug. 28 and Sept. 5. A line has been drawn to show the velocities given by the Kutter formula with n equal to 0.011.

The observations of May 22, falling as they do, near the upper left-hand corner of the diagram, show that the friction head for a mixture containing large proportions of surface loam is somewhat less than where the material is mostly sand and gravel, the rate of pumping solids being greater on that date than on Aug. 28. The data for Sept. 5 falls considerably to the right of that for Aug. 28, owing to greater proportions of solids.

If the proportions and character of the solids could be kept constant and the velocity varied, the relation between friction slope and velocity would be represented by a curve, somewhat similar to the line shown, but located farther to the right. The distance to the right of the given line would increase as the proportion of solids increases. That is, there should be a family of curves for each experiment, each curve representing a fixed proportion of solids. The curve for a given proportion of solids would vary in location as the material changed, moving to the left as clay or loam replaces the sand and gravel and vice versa.

Although the variations in friction loss, shown on the diagrams, must have been due primarily to changes in pumping mixture, it is possible that some variations were also produced by material deposited in the bottom of the pipe when the velocities were comparatively low and the proportion of solids comparatively high. This filling may have been great enough at times to have caused an appreciable reduction in the effective cross-section so that the velocity within the pipe was different from that measured at the delivery end. However, there is no way to allow for such effects since the extent of the filling could not be determined.

The clear water observations of May 11, when the delivery line was practically the same as on May 22, compared with those of Aug. 28, show that for these dates differences in friction head due to differences in pipe alignment or in the pipe itself were unimportant.

Pumping conditions were much improved when sumps two and three were put into operation, due to the changes in pump layout, described in the *Engineering News-Record* article previously referred to, the power consumption being reduced from about 0.026 kw.-hr. per cubic yard per foot of head at sump one to about 0.010 kw.-hr. at sump three.

Arthur E. Morgan is chief engineer of The Miami Conservancy District, Charles H. Paul is the assistant chief engineer, and C. H. Locher is the construction manager. H. S. R. McCurdy is the division engineer in charge of the Englewood dam.

Capillary Moisture and Its Effect on Highway Subgrades

By W. W. McLaughlin
Senior Irrigation Engineer, U. S. Bureau of Public Roads, Washington, D. C.

An article appearing in the current issue of "Public Roads," the official publication of the U. S. Bureau of Public Roads.

ONE of the basic necessities in a pavement is a dry, well drained foundation or subgrade. The prevailing practice is to provide drainage by means of open ditches, covered drains, or both, for the removal of free surface or free ground water. Even where this precaution has been taken, many highway pavements have failed because of wet bases. In other instances, in the arid sections of the country, pavements have at least partially failed where drainage was not thought to be necessary, and these partial failures have resulted, as far as could be determined, because of moisture distribution in the subgrades.

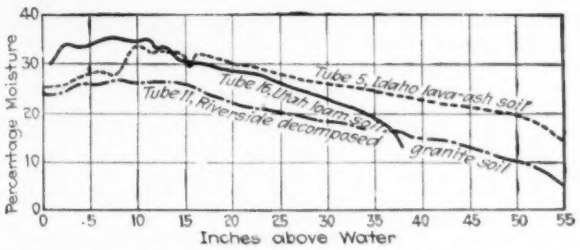
Why do these highways fail? Why do the foundations become wet and unstable in the face of accepted drainage methods? These are live questions bothering many highway engineers and now causing much concern in connection with highway pavement construction.

That capillary moisture may be the cause of some highway troubles and even failures has but recently been suspected. The writer's interest has been aroused in this question by investigations of the movement of soil moisture by capillarity by the division of irrigation investigations of the Bureau of Public Roads. It is the purpose of this article to present briefly a few of the data which may have a bearing upon the subject.

The force of capillarity acts equally in all directions, while the force of gravity acts only in a direction vertically downward. These two forces are at work all the time upon any moisture which may be within the soil. Capillarity is augmented by gravity when working in a direction downward from the horizontal and is reduced by that amount when working in a direction upward from the horizontal.

Table I shows clearly the effect of gravity on the capillary movement of soil moisture, both as to the distance the latter will reach in a given time and the total quantity of water moved. Expressed in round numbers and based upon the figures for the vertical column the moisture had moved downward at the end of 30 days two and one-half times as far in the soil column inclined downward at an angle of 15 deg. and two and three-fourths times as far in the soil inclined downward at an angle of 30 deg., as it had moved upward in the vertical column. At the end of 30 days three and one-fourth times as much water had moved down the 15 deg. incline and three and nine-tenths times as much water had moved down the 30 deg. incline as had climbed upward in the vertical column.

Table I also shows that the quantity of water per unit over the entire wetted length is greater for the columns inclined downward than for the horizontal or vertical columns. That some idea may be obtained of the unit distribution of moisture in a vertical soil column and in a column inclined downward at an angle of 30 deg. Table II is given.



RELATION BETWEEN MOISTURE CONTENT AND HEIGHT ABOVE WATER

TABLE I. CAPILLARY MOVEMENT OF SOIL MOISTURE FROM A WATER SURFACE INTO A LAVA ASH SOIL COLUMN FOR VARIOUS PERIODS OF TIME, AND THE TOTAL QUANTITY OF WATER MOVED

		Direction Moisture Moved			
	Time in Days	Vertically Upward Inches	Horizontal Inches	Downward 15° from horizontal Inches	Downward 30° from horizontal Inches
Distance moved	1	16.25	22.9	24.80	26.20
	2	23.59	30.85	34.05	36.05
	3	27.67	37.55	41.70	42.35
	7	37.42	57.40	63.40	66.25
	15	46.92	81.45	95.25	99.70
	30	54.50	109.90	137.10	150.10
Water moved in acre-inches, per acre	1	0.403	0.605	0.655	0.605
	2	0.554	0.806	0.907	0.857
	3	0.706	1.008	1.109	1.058
	7	0.907	1.562	1.764	1.764
	15	1.169	2.369	2.722	3.024
	30	1.320	3.58	4.334	5.141

In Table II the average percentage of moisture per inch in the inclined column is greater by 4½ per cent than that in the vertical column. The per cent of moisture in the end of the column away from the body of free water is 42 per cent greater in the inclined column than in the vertical column. This circumstance is of the greatest importance, because the supporting strength of the subgrade depends upon the percentage of water in the soil.

TABLE II. DISTRIBUTION OF MOISTURE IN SOIL COLUMNS BY 2-INCH SECTIONS FROM THE WATER SURFACE

(Yolo gravel-clay loam)

	Percentage of Moisture in the Soil Column	
Distance from water Surface	Vertical Column Per Cent	Inclined Downward 30°, Per Cent
2 inches	37.48	36.03
4 inches	36.72	35.92
6 inches	37.31	35.00
8 inches	37.68	34.39
10 inches	35.85	34.74
12 inches	32.35	34.28
14 inches	30.60	33.61
16 inches	28.20	32.30
18 inches	26.05	31.00
20 inches	23.25	29.94
22 inches	20.18	28.70
Average	31.45	35.99

The percentage of moisture found in a vertical soil column is not related directly to the height above the ground water except at the upper end, and then in only a very general way. The maximum percentage of moisture may be found and, in the clays and loams, usually is found several inches above the water surface. This point is illustrated by Fig. 1.

From the figure it is seen that in the Riverside soil the greatest per cent of moisture is found about 15 in. above the water surface. In the Idaho lava ash about one-half of the soil column is up to capillary saturation. In other words, there would be little difference from the standpoint of moisture content whether the pavement was 6 in. or 24 in. above the water surface.

Effect of Gravel Subbase—Stratified soils of different types are usually found in the alluvial areas and the relative percentage of moisture in the several strata is of interest. Several soil columns were made up of sand, loam, and clay in alternate layers, differently arranged. These columns after having stood for several days were analyzed for moisture. It was found that, at the same height, the several strata contained approximately the same percentage of moisture as a column of one type representing the various soils mingled. Table III gives the results of a typical instance. The made-up soil column has 6 in. of clay on the bottom, then 4 in. of river sand, and then a layer of clay, 6 in. thick, of the same type as the bottom layer. The second column of the table gives the percentage of moisture at various heights in a soil column made up as described above, and column 3 gives the percentage of moisture found at the corresponding heights in a uniform soil column of the type found in the made-up column at the respective heights.

TABLE III. DISTRIBUTION OF MOISTURE IN SOIL COLUMN OF UNIFORM TYPE AND IN A STRATIFIED COLUMN OF DIFFERENT SOIL TYPES

Distance Above the Water	Percentage of Moisture Made-Up Column, Per Cent	Percentage of Moisture Uniform Column, Per Cent
Average from 0 to 6 inches	44 39	47 95
6 to 10 inches	13 46	16 10
10 to 12 inches	43 52	40 78
12 to 14 inches	14 89	14 21
18 inches	13.72	12.19

In a soil column made up of 16 in. of clay on the bottom and sand on top, the moisture had not moved up into the sand more than 3 in. after standing 20 days. There was only 5 per cent of moisture in the sand, although there was 39 per cent in the top of the clay. Other similar tests indicated the advantage of a top layer of sand or gravel in keeping the moisture percentage low near the upper end of the soil column. The top layer of sand also seems to permit only slow movement of the moisture from the clay upward into the sand. Generally speaking, if the sand or gravel is placed at the bottom and a topping of clay or loam provided, the sand or gravel must be thick enough to prevent the rise of moisture to its upper edge to be effective. While the sand layer may transmit the moisture slowly, the clay or loam will readily take it up. Retardation of the movement within the limits of a few weeks is not of material importance or advantage in pavement work.

Extent of Capillary Movement—Questions often arise as to how far moisture will be brought up in different soils by capillarity from a body of free water, and at what rate the water will reach points at various heights above the water surface. Table IV gives some indication of the answers.

TABLE IV. RISE OF CAPILLARY MOISTURE IN SOILS FOR DIFFERENT PERIODS OF TIME AND RATE OF MOVEMENT OF THE MOISTURE

Distance above Water Surface	—Light Clay Loam— Time in days	Acre-Inches per day	—Lava Ash Soil— Time in days	Acre-Inches per day	—Sandy Loam— Time in days	Acre-Inches per day
12 inches	$\frac{5}{12}$	0 193	$\frac{1}{2}$	0 193	$\frac{3}{4}$	0 151
24 inches	$6\frac{1}{2}$	0 0035	2	0 116	37	0 0001
36 inches	55	0 0018	$6\frac{1}{2}$	0 035	...	None
48 inches	219	0 0001	17	0 009	....	.....
60 inches	....	None	50	0 005	....	.....
72 inches	....	.....	200	0 0001	....	.....

The table but emphasizes the fact that the finer the soil texture the greater its capillary power, and it also shows the fallacy of attempting to keep the subgrade dry by shallow drainage or the building of low fills over soil saturated with water or where the underground water table is nearer than 5 or 6 ft. to the surface, unless the soil be sandy. The table shows that in lava ash soil of the type used in the experiment there will be brought to the surface through 5 ft. of soil 1.8 acre-inches of water in a year, and through 4 ft. of this soil there would be brought to the surface in the same time 3.3 acre-inches. Five and one-half inches of water would be brought up through 1 ft. of sand, but through 2 ft. of sand only $\frac{1}{4}$ acre-inch of water would be brought up in a year.

It is difficult to estimate the amount of the evaporation of moisture from below the midpoint of a paved highway. Near the outer edge of the pavement the rate of evaporation may be very rapid, but in the center the moisture would first have to move horizontally to a crack or through 8 or 10 ft. of soil to the outer edge of the pavement. On the deserts of the West the rate of evaporation from a wet soil may be $\frac{1}{4}$ in. per day, and under some conditions even more. The rapid evaporation of the moisture near the outer edge of the pavement might, and sometimes does, result in a dry subgrade at and near the outer edge of the pavement and a wet subgrade in the center. In the heavier soils this would result in a subgrade of unequal supporting power and, through contraction and expansion resulting from unequal moisture content, leave an unsupported outer edge of the pavement or a mushy yielding subgrade center. According to Prof. William H. Burr, the safe bearing power of dry clay is 4 to 6 tons per square foot; that of moderately dry clay 2 to 4 tons; and that of soft, moist clay 1 to 2 tons. Hool and Johnson give as the safe-bearing power of quicksand $\frac{1}{2}$ to 1 ton per square foot, gravel and coarse sand well cemented 8 to 10 tons, and clean dry sand 2 to 4 tons. These figures indicate the effect of moisture in the subgrade in its relation to load-bearing strength.

Where a highway is built through a country having a transverse slope of 15 deg. or more the movement of moisture down this slope by capillarity is relatively very rapid and extensive. If a sand or gravel stratum is present (especially if it be on top of a clay or other impervious or semi-impervious layer) then the capillary movement of moisture is much more rapid and will extend for great distances. Such soil conditions are not at all uncommon in an alluvial country and afford ideal conditions for the capillary siphoning of water.

The capillary movement of soil moisture from a free water surface is very rapid for the first 48 hr., and for that reason shallow side drain ditches are not effective in preventing the capillary movement of moisture into subgrades, especially if these ditches are at all near the pavement. Deep drains are not effective against capillary moisture unless placed below the limit of capillary rise of moisture in the soil under consideration.

That capillary moisture has caused soggy, wet subgrades is beyond question and unless effective preventive measures are taken it will continue to cause highway troubles.

The data outlined above were obtained from experiments conducted on the capillary movement of soil moisture where the source of the moisture was free water. The capillary movement of soil moisture from a wet soil to a soil containing a smaller percentage of water differs from what has been shown only in quantity. However, the rate and extent of movement of the moisture under the last named condition is relatively so little as to be almost negligible in highway pavements.

Seek Rail Routes to Canadian Oil Fields

Authority to construct railroads to the oil regions of northwest Canada has been sought by three companies. Two of these, the Slave River Co. and the Fort Smith Railway Co., ask charters for building lines across the portage from Smith Landing to Fort Smith on the Slave River to by-pass the rapids and shoals at this point. The government railway committee has asked the two companies to arrange a charter for a single line. The Edmonton & Mackenzie River Co. seeks a charter for a line from Fort McMurray, on the Athabasca River, to the junction of the Jackfish and Peace Rivers, and thence to the mouth of the Hay River at Great Slave Lake. Last year a charter was secured by a company backed by British financial interests for a line between Great Slave Lake and Hudson Bay at a point 1,000 miles north of Port Nelson and Fort Churchill.

Current Water-Works Problems and Practice

Abstracts of Papers and Technical Discussions Before the Cleveland Convention of the American Water Works Association—Comparative Costs of Pumping Plants and Reservoirs to Meet Excess Consumption Rates—Other Studies

The Small Plant Operator as Scientist

By Abel Wolman
Assistant Engineer, Maryland State Department of Health

ALL plant operators may be divided into three classes: (1) Those who feel that they are scientific but hesitate to present their observations because of inherent modesty; (2) the practical, who observe but do not report because of a supposed lack of scientific language; (3) those who neither observe nor report. It is to the first two classes that one must look for real development in water treatment, since they are the first to encounter new problems and the first to try out new solutions. A scientific hypothesis is useless if it is not in accord with the facts everywhere. A scientific solution is worthless if it does not solve our problems. Both the hypothesis and the solution must be tested by the plant operator.

When we speak of a problem in water treatment we are prone to emphasize its simplicity rather than its complexity. We find it easy to fall into the error of considering "water" as a definite thing, a simple compound, instead of regarding it always as a most variable substance, delicately fluctuating with atmospheric, geographic, and geologic influences. When water is considered in this sense each water filtration plant becomes a laboratory, a scientific structure, a research bureau, where facts and opinions may and should be tested out upon the peculiar and rare fluid there being handled. When a new hypothesis is announced each plant operator has the opportunity to make a real contribution to science and to practice by determining whether it tallies with the phenomena experienced with his own rarity, the little stream used in his plant. Likewise, he has the continual advantage of learning whether older theories account for the present observations and whether older methods are adequate. Each small plant stands, therefore, in the position of a special research laboratory upon the director of which there has been placed the duty of watching and interpreting a continuous series of experiments performed under conditions common to no other laboratory. I emphasize the distinctiveness of each plant, since even on the same stream, a few miles apart, the water has undergone profound change which converts it into a new substance, with new, though possibly slightly varied, attributes.

If we accept the concept of each plant as a true specialized investigative bureau and of water as a variable and not a constant substance what operator has the right to say that he is not or should not be a scientific observer? His duty, whether he likes it or not, has been enlarged from that of valve-operator to investigator. His responsibility is greater than to his immediate community. It is national and even international, for the plant operator is now a research worker, and the fruits of research are limited only by the infinite.

Sanitary Survey of Lake Erie Opposite Cleveland, Ohio

By J. W. Ellms
Engineer Water Purification, Cleveland Water Department

IN CONNECTION with extensive studies made by the Division of Water for the purpose of preparing plans for the present and future expansion of the water-works of Cleveland, it seemed desirable to undertake a sanitary survey of Lake Erie opposite the city and its suburbs. The principal object in view was to discover, if possible, areas of least pollution in which might be located new water-works intakes. The work was done in 1920.

The area of lake studied covered about 250 square miles. Sampling stations were located at various points by a system of intersecting lines running parallel with or perpendicular to the shore. Some 1,800 samples of water were collected from the surface and from various depths. These samples were examined principally by bacteriological methods.

The conclusions reached were that the average quality of the water four to five miles from the shore along the entire thirty-two miles investigated was suitable for water supply purposes; that a better quality of water could be found nearer the shore west of the mouth of the Cuyahoga River than east of it; and that in general there were wide fluctuations in quality due to the effect of winds and storms setting up currents in the lake, which carried the sewage polluted shore water out into the lake.

Investigation of Tastes and Odors in the Cleveland Water Supply

By J. W. Ellms
Engineer Water Purification
AND
W. C. Lawrence
Chemical Engineer, Cleveland Water Department

A LONG investigation undertaken to locate the source of the so-called "carbolic acid" taste which occurs at times in the Cleveland water supply showed that the cause of this foul taste was waste liquors from byproduct coke oven plants. It was found that very small quantities of phenol (carbolic acid) contained in these trade wastes were capable of producing the obnoxious taste complained of by water consumers, when the polluted water was chlorinated. In consequence, the "taste or odor" test, produced by chlorinating a large number of samples of water from the Cuyahoga River from the lake between the mouth of the river and the water-works intakes and from the intakes themselves, was employed. Many samples from sewers and from a great variety of industrial plants were also collected and tested.

The conclusion reached was that the cause for the taste was attributable principally to the waste liquors from the ammonia stills of byproduct coke oven plants, and that the phenol, although in minute quantities in these liquors, was quite sufficient to produce a foul tasting and smelling compound if the waste entered water-works intakes and came in contact with chlorine applied to the water for disinfection purposes. Fortunately very direct evidence was obtained of the diffusion of the waste as it emerged from the mouth of the Cuyahoga River, and of its path in reaching the intakes. Several large byproduct coke oven plants are located on the Cuyahoga River.

The Rate of Solution of Sulphate of Aluminum

By J. W. Ellms, A. G. Levy and L. A. Marshall
Cleveland Water Department

A STUDY of the rate of dissolution of alum in water under certain conditions was undertaken to discover the factors influencing the rate of solution in order that the proper size of solution and storage tanks should be selected for the large filter plant now being designed for the city of Cleveland. Upward flow solution tanks were experimented with and sulphate of alumina of various sizes used in determining the rate of solution. Rates of flow from 2.5 to 10 in. vertical rise per minute were employed, and alum as dust or in pieces from ¼ in. to 3 in. in diameter were tried. The effect of the temperature of the water upon the rate was also studied.

The general conclusion reached was "that for all practical purposes, provided the point of saturation is not reached

by the water in passing through the alum in upward flow tanks within the limits of these experiments; namely, 2.5 to 10 in. vertical rise per minute, the length of time required to dissolve alum in any given condition of subdivision of the solid, is a factor only of the temperature of the water and of the size of the pieces of alum, and is independent of the total weight of alum to be dissolved."

Water Main Cleaning in Kansas City, Mo.

By Charles S. Foreman
First Assistant Engineer, Water Department, Kansas City, Mo.

THE author believes that a summary of his experiences in the line of water main cleaning in Kansas City during the past three years will be of value to other waterworks superintendents desirous of instituting similar work in the system under their jurisdiction and that the following essential facts based upon his experiences will help to answer some of the questions which are usually asked:

(1) Cleaning can be so arranged that a main need not be out of service longer than twelve hours for cleaning. (2) The cleaning process is not injurious to the mains. (3) An increase in carrying capacity of from 60 to 85 per cent was obtained in large mains and the carrying capacity of such mains was restored to that of new pipe. (4) The saving in coal costs alone, derived from cleaning, will pay the entire cost of cleaning within from one to three years. (5) Laying of additional mains to obtain increased capacity can be postponed until the consumption demands are equal to the maximum capacity of the old main on the basis of new pipe. (6) When taking as credits such items as coal saving and postponement of obligatory laying of new mains the entire cost of cleaning is saved within from six months to a year.

Service Years	Size In.	M.G.D. Normal Flow	Loss of Head per 5,000 Ft. Uncleaned	Loss of Head per 5,000 Ft. Cleaned	Annual Coal Cost to Operate Line Uncleaned	Annual Coal Cost to Operate Line Cleaned	Annual Coal Saving	Size Required to Obtain Increase in Capacity If Not Cleaned In.	Estimated Cost 5,000 Ft.	Interest on Expenditure 5 Per Cent	Total Annual Saving	Total Cost of Cleaning
41	16	2 4	24 00	7 50	$462 53	$144 53	$318 00	12	$27,200	$1,360	$1,778 00	$1,715
42	20	3 4	23 50	5 60	641 60	152 89	488 71	16	33,100	1,655	2,143.71	2,095
28	24	5 0	12 60	5 25.	505 90	210 79	295 11	16	33,100	1,655	1,950 11	2,675
33	30	12 0	23 50	9 00	2,264 46	867 24	1,397 22	24	70,000	3,500	4,897 22	3,115
33	36	16 0	15 25	6 00	3,740 52	1,471 68	2,268.84	30	73,500*	3,675	9,618.84	2,675

Annual cost for fuel to pump one million gallons 1 foot high at Quindaro = $0 042.
Annual cost for fuel to pump one million gallons 1 foot high at Turkey Creek = $0 022.
* No pavement or rock. Surface supply Missouri River water.

For two or three years prior to the summer of 1918 there was always a lack of adequate pressure in the north and east portions of Kansas City. This district is fed from the Turkey Creek Pumping Station through one 20-in. and one 30-in. cast-iron water main. The question of laying additional feeder mains into these districts was abandoned because of the exceedingly high prices of material and the lack of funds.

Tests were run on about 6,000 ft. of 30-in. high pressure discharge line to determine the interior condition and carrying capacity of this pipe—laid in 1886. Taps were made exactly 1,000 ft. apart upon a straight length of the main, there being no services or connections to the main between gaging points. At each of these points 1-in. corporation cocks were installed for inserting pitometers and additional corporation cocks for pressure lines. A 2-in. pipe was connected to each of these taps and 1,000 ft. of this pipe laid along the surface of the ground bringing the two together so that a U-tube could be connected in to measure the differential pressure between the two points. The 30-in. pipe was double traversed at each pit and the average traverse co-efficient obtained. A pitometer was then set at each pit for checking quantities flowing through the 30-in. main.

The scale on the differential U-tube was graduated in 0.01 divisions and by using a liquid of specific gravity of 2 in this tube the readings obtained were in feet loss of head per thousand feet.

The advantages inherent in this method are that it is not necessary to obtain the difference in elevation between the two points, and that it eliminates the use of spring gages. Piezometers could not be used because of the high pressure, 125 to 150 lb. The test extended over a 24-hour period so that both maximum and minimum velocities in the pipe could be obtained.

The average pipe co-efficient, as computed by the Williams & Hazen formula, was 69.69, this being lower than that in the Williams & Hazen tables for pipe forty years old. From these tests it was evident that the 30-in. line was far below the carrying capacity of new cast-iron pipe. A contract was awarded to the National Water Main Cleaning Co. for the cleaning of 6,000 ft. of this 30-in. pipe.

Similar tests run after the pipe had been cleaned showed that the average pipe co-officient was brought up to 116, and at low velocities as high as 120, the carrying capacity of this pipe having been restored to nearly that of new pipe.

The cleaning of the 30-in. pipe gave such excellent results that contract was let to the same company for the cleaning of additional 30- to 16-in. feeder mains into the northeast section of the city. Similar tests were run on each of these pipe lines both before and after cleaning. In all of these cases the pipe after being cleaned was restored to carrying capacity and corresponding loss of head as indicated in Williams & Hazen tables under co-efficient 120.

The contractor's price for cleaning ranged from 26c. per foot for 16-in. pipe to 45c. per foot for 36-in. pipe and the total cost, including all expenses for operating valves, cutting and repairing pipe and for all necessary sleeves and material was $22,046 for 43,837 lin.ft. of pipe cleaned, or 50.3c. per lineal foot for all sizes. The total cost of cleaning the various sizes including pavement repairs and operation of valves, etc., was as follows:

Length, Ft.	Size, In.	Total Cost	Cost Per Lineal Foot, Cents
7,202	16	$2,472.52	34.3
7,280	20	$3,056.80	41.9
3,371	24	$1,813.56	53.5
8,984	30	$5,604.93	62.3
17,000	36	$9,098.28	53.5

The accompanying table shows the length of time in service, the annual operating cost for coal before and after cleaning of the various sizes cleaned, the investment required and the annual interest thereon to obtain the increased capacity by laying new mains, and the total annual saving all being based on 5,000 ft. of each size and on the normal flow through the pipe at time tests were made.

State Versus Local Viewpoint on Filter Plant Control

By Robert B. Morse
Chief Engineer, Maryland State Department of Health
Chief Engineer, Washington Suburban Sanitary District

WITHIN recent years the writer has found himself in the peculiar position of having the responsibility both of supervising the operation of water purification works for the state and of operating such works for a sanitary district. During this period the opportunity has arisen to study the contrasting mental attitudes which differences in function create in the same or different persons.

The duties of operator and state representative may be differentiated psychologically by remembering that in the first case emphasis is placed upon the means and the economy of producing a good water, while in the second the end product is all-important.

Owing to comparatively recent development of the scheme of water supply control by the state, it has come

about that a large proportion of state representatives, particularly those in the field, are young men; older men are not available in many instances because state budgets are still exceedingly lean. We then have before us at the start "youth" and its possible accompaniments—inexperience, lack of tact, impatience, and often self-importance—all qualities which, of course, older men are supposed to have eliminated or else to have learned to conceal.

If the state representative, regardless of his lawful powers, will approach the plant operator in a spirit of helpfulness and with an open mind, if he will study carefully each plant before arriving at conclusions regarding improvements in construction and operation, if he will consult with, rather than rail at, the plant operator in the realization that the good will of the latter is essential before any fruitful changes in control will be possible, if he will keep before him the desire to help and behind him the desire to order, then he will disintegrate his part of the barrier.

The task for the operator is a more difficult one, since it is that of converting suspicion into co-operation, where the fruits of co-operation are not at first apparent. The state official should find it easy to forget his badge, because by so doing the development of his plan becomes less arduous. The operator, however, has a greater difficulty in visualizing the benefits which accrue to him by accepting the offering of the upstart. He feels that somehow he gives more than he receives, that he knows his own plant better than anyone else can, that his dignity suffers by permitting any interference or suggestion. If he may be brought to conceive, however, that youth may gather experience quickly through the continuous co-ordination of study of a number of purification works and may obtain an actual maturity of judgment through contact with varied problems at a series of plants, and that daily routine may have prevented him from keeping pace with developments in his field, then the operator may see the advantage of co-operation. Suspicion will almost always succumb to the helpful presentation of new ideas. Where views are continually changing and where new methods are appearing the possibility of gaining knowledge of these through state assistance will do much to remove the antagonism of the operator.

Tastes and Odors From Chlorination

By Walter A. Sperry
Chief Chemist

Loyd C. Billings
First Assistant Chemist, Filtration Plant, Grand Rapids, Mich.

AS WE view this whole problem the most practical suggestions as to the feeding and control of chlorine has come from the writings of Abel Wolman, of the Maryland State Board of Health. (See *Journal Industrial Chemistry*, March, 1919; also *Engineering News-Record*, April 14, 1921, p. 639.)

Chlorine has been at once the operator's great benefactor and sore trial as he has sought to preserve public health and avoid public condemnation through its use. All have felt the constant need of such methods of control as would assure a safe water without the constant danger of tastes.

Wolman's chlorine absorption method of test, along with his residual chlorine test, appears to meet this dual problem. At Grand Rapids we have followed, for the most part, a plan of "invariable dosage." We have always felt its inadequacy. Tastes have developed when none were looked for and conversely. Disinfection has not always been satisfyingly complete. Limiting quantities producing tastes have been variable and puzzling.

For the past two years daily studies as to the chlorine absorption values of our raw, settled and tap water along with their oxygen consumed values have been made in the hopes of finding a more logical control than what we were making use of. They have lead us to believe more and more in the final fitness of the methods cited to this end.

Conclusions drawn from daily operation results and also from experiments at Grand Rapids are:

Grand Rapids experience shows that comparatively large doses of chlorine are necessary to disinfect because of large amounts of organic present capable of absorbing chlorines.

Where the plan of invariable dosage is followed there is great danger of running into taste difficulties. Chlorine absorption studies show the range between the necessary amount of chlorine for disinfection and the amount to give taste to be small.

Some method of controlling chlorine feed is shown to be necessary as without such method the results at Grand Rapids show danger of running into taste difficulties and insufficient disinfection.

The chlorine absorption method as outlined by Mr. Wolman is consistent and accurate. Sixteen months' experience with testing method shows its practicability. It is the only quick method by which the chlorine demand of a water may be determined with accuracy. So far as this experience goes to show, chlorine demand, as indicated by this method, can be satisfied and enough more added as excess to disinfect and yet keep away from taste.

While such factors as turbidity and oxygen consumed show only a general relationship they all point to a consistency existing between them and the chlorine absorption values. This consistency argues well for confidence in the point of view taken by writers.

We believe the whole problem of tastes as applied to filtration plant practice is related to improperly proportioned dosages.

Coagulation and Sedimentation with Chemicals

By J. W. Ellms
Engineer Water Purification, Cleveland, Ohio

LIKE all new developments in science, colloidal chemistry has been seized upon to explain many phenomena which are complex, and which will eventually be found to require the formulation of entirely new and unrelated principles. If investigators will bear in mind, that from the mass of facts concerning the colloidal state of matter, principles and laws are slowly being developed, and by use of which explanations of some of the obscure phenomena in coagulation, sedimentation and filtration of water may be found there may be a real advance in the art of water purification.

Licensing Water Purification Plant Operators in New Jersey

By Charles H. Capen, Jr.
Assistant Sanitary Engineer, State Department of Health, Trenton, N. J.

ACTING under chapter 23 of the New Jersey Laws of 1918 the State Department of Health licenses operators of water purification plants. The act provides that every purification plant must have a licensed operator, but that licenses should be issued to all operators holding their positions prior to the time of the passage of the act upon proper certification by the municipal officer, corporation or individual, under whom the operator works. The department is given the authority to revoke a license, when upon the operator being given a hearing he shall be judged incompetent to manage the plant in his charge, or shall have been wilfully negligent in his duty, or shall have disregarded or disobeyed the rules or regulations of the department. There is provided a penalty of $10 for each day on which the violation occurs. It is further provided under the act that either before or after the institution of penal proceedings the department may proceed to prohibit such violations by injunction, and to obtain such other or further relief as the court may direct.

An abstract of rules and regulations issued by the department to govern licensing follows:

There shall be three classes of licenses issued to persons examined as superintendents or operators of water treatment works:

A First Class, or Superintendent's, License shall be issued only to those persons having the qualifications and knowledge necessary for the satisfactory supervision of the operation of water

treatment works, including the following processes: Sedimentation, coagulation, filtration, and disinfection; and for making the standard tests, both chemical and bacteriological, necessary for testing and controlling the efficiency of all the various processes used in water treatment works; and informed in general as to the mechanical equipment and devices used in water treatment works.

A Second Class Operator's License shall be issued only to those persons having the qualifications and knowledge required in order to satisfactorily operate or control one or more of the processes required for a Superintendent's License; and having knowledge sufficient for the making of the routine standard test, both chemical and bacteriological, for testing and controlling the efficiency of the various processes utilized in water treatment works which he expects to operate.

A Third Class Operator's License shall be issued only to those persons having the qualications and knowledge required in order to satisfactorily operate or control one or more of the processes not covered in the First Class License and the Second Class License. This class applies only to those operators having charge of a plant at which the removal of iron or disinfection is the only process of treatment.

As provided by this act there were sixty-five licenses issued without examination, and fourteen licenses have been issued upon examination.

In each case possible representatives of the department have spent from one to four days at the plant with the applicants for examination, and have drilled them in the routine fundamentals as well as in some of the more involved chemical and bacteriological tests. In other cases the applicants have come to the offices of the department and have spent one or two days going over the operation of the plant from every standpoint possible without actually being at the plant in question.

Application of Colloid Chemistry to Sludge Pressing

By John Arthur Wilson, Wm. R. Copeland and Henry M. Heisig
Sewage Testing Station, Milwaukee, Wis.

THE viewpoint of modern colloid chemistry is the logical one from which to attack the basic problems of sewage disposal because the solid organic matter of sewage consists chiefly of an agglomeration of extremely complex substances in the colloidal state. The sludge from the activated sludge process at the Milwaukee sewage testing station is not in the best condition for filter-pressing. By adding sulphuric acid to give the sludge its optimum active acidity (hydrogen ion concentration), the rate of filter pressing can be increased by as much as 400 per cent. By adding chromium or aluminum sulphate in proper amount and then the amount of sulphuric acid necessary to bring the sludge to its optimum acidity, the rate of filter pressing can be increased by as much as 900 per cent. Iron sulphate, or copperas, is no more effective than acid alone. The per cent of water in the sludge has a marked effect upon the increase in efficiency brought about by treating and should be regulated. Putrefaction of the sludge undoes the effect of aëration. The rate of filter pressing decreases with time and can be expressed quantitatively as a function of the time.

SLUDGE PRESSING TESTS ON ADDING ACID

Gallons pressed	2,871	2,673	3,193	3,228
P value	7.4	7.7	7.4	7.6
Acid added, c.c. per gal.	.....	2.50	1.04	2.63
Hours required for pressing	23.8	6.0	5.3	6.4
Cake obtained, lb.	1,407	1,118	1,275	1,240

Shorter Abstracts and Discussions

The Romance of Water Storage—A plea for filtration and chlorination rather than placing dependence upon the sanitary protection of water supplies and upon the beneficial effect of water storage was presented by George A. Johnson, New York City, under the caption given above. In conclusion, the author advocated the use of all four lines of defense while still emphasizing his main thesis. Written discussions, based on advance copies of the paper, Mr. Johnson said, showed agreement with his arguments by a dozen state boards of health and sanitary engineers. In the oral discussion, R. S. Weston, Boston, said that he was in general agreement with Mr. Johnson's contentions but that the same general line of argument could be applied to filtration and chlorination as to sanitary protection and storage — for instance, the filter operator may sleep at his post.

Water Rates—A paper on Water Rates was presented by Nicholas S. Hill, Jr., New York City, and one on Municipal Rates by E. E. Bankson, associated with J. N. Chester, Pittsburgh, and C. A. Finley, chief Bureau of Water, Pittsburgh. Mr. Hill maintained that the basic rate making principles should be the same for private and public plants, including the distribution of the cost of water between the consumer and the taxpayer. The authors of the other paper urged that in the case of municipal-owned works the rates should vary with "the ownership of the works"—or according to capital contributions to meet first cost, whether from consumers or taxpayers. In each paper a rate structure theory was elaborated. After considerable general discussion it appeared that there was general agreement between the authors of the two papers; also that neither they nor most of those who discussed the papers believed that municipal plants should collect rates to pay capital charges on cancelled bonds.

Filtration from the Operator's Standpoint—Seven short papers on this topic were presented in succession and then discussed together. In a paper on filter loads, H. W. Streeter said that a water filter may be considered as presenting a series of barriers, the efficiency of which depends on efficient design and operation. Ohio River water studies indicated that the Public Health Service standard of 500 B. Coli per c.c. might be increased to permit 650 in unfiltered water and still give only the standard 2 coli in the treated water.

In a paper by L. O. Bernhagen, assistant engineer, Texas state Board of Health, the two-weeks school for filter plant operators conducted jointly by the Board and the University of Texas was described and a proposed legislative act providing for licensing filter plant operators was outlined.

Most of the discussion on this group of papers centered on tastes and odors due to chlorination and on the alleged tendency of the day to accept low filter efficiency and rely over much on chlorination. A number gave data and opinion to the effect that chlorination tastes always come from phenol in industrial wastes or else overdoses of chlorine. Instances were given of tastes attributed to the action of chlorine on phenol from coal tar paint in water tanks. Stress was laid on value of the Wolman chlorine absorption and excess or residual chlorine tests.

Arguments pro and con as to the efficiency of filters alone, before chlorination came into use, and as to whether water standards are higher now, led to renewals of the dictum that chlorination should be regarded as a supplement rather than a substitute for filtration, and finally to assertions by Allen Hazen that in the old days it was not claimed that filtration removed *all* disease germs and stopped all deaths from them and that bacterial standards are undoubtedly higher now than twenty years ago.

Superintendents' Day—Two sessions were given over to the superintendents. A half dozen papers were presented and an opportunity given for topical discussions on a variety of subjects. Fred B. Nelson, New York City, described the use of logarithmic straight-line diagrams for determining by one flow test of a meter its capacity at all pressure losses.

Tapping Large Steel Mains—Underlying principles essential for the successful tapping of large steel water mains were outlined by D. F. O'Brien, East Orange, N. J. Because of the large variations in the cross sectional contours of steel pipe, a cylindrical sleeve would require too great a thickness of lead at some points for calking. Accordingly, a ring is used to get the pipe contour so the sleeve may be properly fitted to the pipe. In pouring and calking sleeve joints more care is necessary on steel than on cast iron pipe. Finally, in cutting out the steel a light constant feed should be used.

Use of Machines in Distribution Construction — Papers describing various machines used extensively for pipe trenching, laying, calking, etc., at Detroit, and employed on a smaller scale at Baltimore, were read by W. Montgomery Mitchell and V. Bernard Siems, of Detroit and Baltimore, respectively. Detroit owns numerous machines and has done much toward standardizing them. Comparative tables and curves for hand and machine work at Baltimore showed large savings by the use of machines. The use of machines by

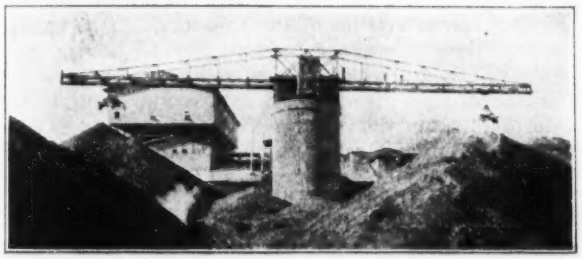
both cities has been forced of late by high labor costs for hand work and at Detroit by the large mileage of mains laid—over 450 miles in the last six years, and 135 miles in 1920 alone. Besides the machines already named, both cities use cranes for handling pipe and pneumatic hammers for calking.

Water Works for Erie, Pa.—The history and improvement of these works since the typhoid outbreak of 1911 was presented by J. N. Chester, Pittsburgh. The paper included a summary of four-day working tests of the reciprocating and the centrifugal pumps in use, with estimates of cost of pumping water based on coal at different prices, all showing lower cost for the centrifugal than for the reciprocating pumps.

Animalculae at the Dallas Filters—Filter stoppage by growths of small "flies" at Dallas, Texas, and prevention of the trouble by applying chlorine to the water before filtration were described by Helman Rosenthal, chemist of the filtration plant.

Concrete Tower Built To Support Revolving Crane

A reinforced-concrete tower was recently built in the center of the clinker storage yard of the Riverside Portland Cement Co. near Riverside, Cal., to support a cantilever crane which is used to pile clinker or to deliver it to a continuous belt conveyor. The crane proper is built of structural steel, but the tower was made of concrete because concrete was cheaper, would be effected less by hot clinker piled around it and would require less maintenance.



CIRCULAR TOWER SUPPORTS 140-TON REVOLVING CRANE

The tower is circular in section, 55 ft. high, and has an inside diameter of 30 ft. The walls are 2 ft. in thickness except at the parapet where the thickness increases to 3 ft. The foundation extends 4½ ft. below the ground level and has a diameter 4 ft. greater than the superstructure. A 6-in. diaphragm or floor supported on beams is located 7 ft. below the top of the tower.

The revolving element, which weighs 140 tons, is supported on a track laid on ties placed radially around the parapet. The two crane arms are each 110 ft. long and operate 50-cu.ft. grab buckets. When operating both buckets, the capacity of the crane is 6,000 bbl. per 10-hr. shift. The seven motors on the crane, ranging in capacity up to 40 hp., are said to cause no vibration.

Chicago Engineer Reinstated

The Chicago Civil Service Commission has reinstated Thomas G. Pihlfeldt, city bridge engineer, who was dismissed last year on charges which led to a protest by the American Association of Engineers against the charges themselves and the manner of trying the case. (See *Engineering News-Record* May 13, 1920, p. 937, and Aug. 12, 1920, p. 334.) The reinstatement is said to have been made on the recommendation of the commissioner of public works.

Remote Control for Railway Switches

ECONOMY and efficiency in railway operation require the elimination of checks to the movement of trains between regular stopping places, as the resulting delays and cost are very serious in the aggregate, especially with heavy trains. A frequent cause of such checks is the use of hand-operated switches at sidings, yard entrances and other outlying points, where a train using the switch must stop while a brakeman goes ahead to operate it.

SIDING SWITCH CONTROLLED FROM DISTANT STATION

With these switches operated from stations, block towers or other convenient points the necessity of stopping trains can in many cases be avoided, with small expense for the installation. In the electric system, a motor-operated mechanism at the switch is controlled readily from almost any distance. As a rule the distance is too great for mechanical operation, the limit for which is taken usually at about 1,200 ft. The apparatus is interlocked with the block and switch signals.

A typical siding installation is that on the Atchison, Topeka & Santa Fe Ry., at Walton, Kan., where local conditions required the eastbound passing siding to be placed west of the station, so that its "heading-in" switch is about 5,000 ft. distant. Frequent delays occurred due to trains being required to stop for hand operation of the switch before they could enter the siding, these delays being especially troublesome from the fact that at time there is a congestion of eastbound traffic. By operating the switch electrically from the station the delay in taking the siding is eliminated, thus facilitating traffic and relieving congestion.

Two eastbound tracks, for fast and slow traffic, converging into one track, constitute a similar case on the Philadelphia & Reading R.R. near Palmyra, Pa. The switch, over 4,400 ft. distant, has been put under the control of the operator at the station, thus eliminating the delays due to hand operation by brakemen to let their trains cut of the slow track. When these trains have a clear signal they now pass onto the fast track at about 20 m.p.h.

Remote control of a main line junction from the tower at an interlocked grade crossing about 3,000 ft. distant is a case of a different kind at Glen Jean, Ohio. The Chesapeake & Ohio Northern Ry. wished to connect with the main line of the Norfolk & Western Ry. about half a mile east of the crossing of the latter road and the Detroit, Toledo & Ironton Ry., at which crossing the Norfolk & Western Ry. had a mechanical interlocking plant. It was decided that the best plan would be to add an electro-mechanical attachment to the existing plant and to operate the switches and signals of the junction from the Glen Jean tower rather than to install a separate tower and interlocking plant at the junction.

On account of the distance, with the first switch about 2,800 ft. from the tower, the cost of the new equipment was nearly three times that of a separate mechanical plant. But the latter would have required the services of three operators, and the saving in labor cost by operating both plants by one set of men warranted the additional first cost.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Rainfall and Runoff Experiments

Reviewed by ROBERT E. HORTON
Consulting Hydraulic Engineer, Albany, N. Y.

RAINFALL AND RUNOFF IN THE MIAMI VALLEY—By Ivan E. Houk, District Hydrographer; Assoc. M. Am. Soc. C. E. Technical Reports, Part VIII, Miami Conservancy District. Dayton, Ohio: The District. Paper; 6 x 9 in.; pp. 234; illustrated. 75c.

As stated in the Introduction, the purpose of this report is to present to the engineering profession the results of rainfall and runoff investigations carried on in connection with the Miami Flood Control Project. The most significant feature of the report is the presentation in detail, of experimental laboratory researches on infiltration of rainfall.

In these experiments, natural soil plats 5 ft. square were selected, each surrounded by an impervious metal wall, and provision made for catching the surface runoff. Four experimental plats were used, two on flat and two on sloping ground, one in each condition being bare and the other grass-covered. In addition to records of rainfall and surface runoff, soil moisture determinations were made in the first two feet depth of soil at frequent intervals. The results are expressed graphically and in tabular form, and tables are presented showing maximum rates of evaporation, of transpiration, and also soil absorption and surface runoff for different typical periods, including one to five days' storms.

In order to check the result obtained for these experiments and secure additional data without waiting the comparatively long time required for the accumulation of such records from natural rainfall, a series of accelerated experiments was carried out by artificial sprinkling of the soil plats. For this purpose, four additional plats were established. The results obtained by sprinkling the different plats at different rates, and for different durations, are presented in tabular and graphical form, graphs being drawn showing the average relations between the rate of sprinkling or rainfall and resulting runoff rate, both with soil initially saturated and not saturated. These two series of observations of experimental studies represent an important contribution to the science of engineering hydrology.

Very little experimental work along these lines has hitherto been done, although its importance has been pointed out in the columns of this journal (*Engineering News-Record*, March 27, 1919, pp. 614, 661). About all that is hitherto available showing material infiltration rates is comprised in the experimental studies of runoff by Wollny, which covered a somewhat wider scope than the Miami experiments, in that the effect of variation in soil character, slope, orientation and vegetation, were all investigated. As regards studies similar to those where artificial rainfall or sprinkling was utilized, there is little else in print than the limited experiments of O'Meara.

In going through this portion of Mr. Houk's report, one finds little to criticize, as the data are fully presented, the discussion is unusually clear and rational, and the conclusions appear to be well confirmed by the experiments. It is to be regretted that a recording rain gage was not utilized in the experiments on natural runoff, since without it, it is impossible to obtain as complete information regarding the effect of rainfall duration and intensity on the various factors as would otherwise be available.

In view of the excellent character of the work done, engineers having to do with problems of flood causation and control will undoubtedly regret that more elaborate experiments, covering wider varieties of character of soil, and different slopes and types of vegetation cover, were not undertaken. As it is, some very important points are still left obscure, for example the exact cause of the persistent increase in infiltration with rainfall rate for all the rainfall rates experimented upon, and the fact that the soil was never found to be completely saturated, even after the heaviest rain.

The latter half of the book is devoted mainly to presentation and discussion of actual rainfall and runoff results obtained at 15 gaging stations maintained by or in co-operation with the Miami Conservancy District throughout various periods of years, and these results are interpreted in the light of the experimental data referred to, and form an important contribution to hydrology. Here, however, it is unfortunate that the physical characteristics of the various drainage basins, notably their average elevations, surface slopes, percentages of culture distribution, soil characteristics and the like, are not given. Such data would facilitate the interpretation of the variations in yield from areas with similar amounts of rainfall, which will be noted in the tables.

The report is accompanied by an excellent bibliography, and is one which should be read by all persons interested in the new and rapidly advancing science of hydrology. It is to be hoped that it will lead to further investigations by others, along similar lines.

Works for Transportation by Water

REVIEWED BY ALLEN HAZEN
Consulting Engineer, New York City

HANDBUCH DES WASSERBAUES: Für das Studium und die Praxis—Von Hubert Engels. Vol. I and II. Leipzig, Germany: Wilhelm Engelmann. Cloth; 7 x 10 in.; pp. 1614; illustrated. Paper; 260m.; bound; 292m.

The first edition of this monumental work was reviewed at length [by Mr. Hazen—EDITOR] in *Engineering News*, Jan. 21, 1915, p. 116. The book, in two large volumes, deals with hydrology, river courses and their improvement, canals, locks, harbors, shipping, ship canals, removable weirs for river improvement, and permanent weirs for storage. It also deals with water power, with protection of land from erosion by water, and with the agricultural relations of water. It does not extend to public water supplies and sewerage systems. The treatment is mainly from the standpoint of the designer; and the author in the preface to the second edition, referring to this, states that one does not learn how to build engineering works by reading books, but only by personal experience in actual construction under competent leadership. Free use has been made of technical publications of all kinds, domestic and foreign, and the text has been revised in many

places because of new material. The number of pages is increased from 1,499 to 1,614, the additions being mainly in the sections relating to weirs, dams, water power, river improvements, and locks.

The treatment is simple but clear and adequate. It deals with fundamentals rather than details. Many useful lessons may be learned from these volumes for application in other fields of engineering. For one who wishes to understand European methods of improving rivers for navigation, and all the allied arts, Professor Engels' work may be accepted as a clear and authoritative statement.

Location, Grading and Drainage of Highways

REVIEWED BY C. J. BENNETT
State Highway Commission, Hartford, Conn.

THE LOCATION, GRADING AND DRAINAGE OF HIGHWAYS: A Concise Discussion of General Principles Illustrated by Current and Recommended Practice—By Wilson G. Harger, C.E., Engineer N. Y. State Dept. of Highways; Former Senior Highway Engineer, U. S. Office of Roads, Author of "Highway Engineers' Handbook," etc. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 294; illustrated. $3.50.

The writer of this book announces in his preface that this is one of four volumes presenting the road problem from the standpoint of the constructing engineer and is intended for the use of students and practicing engineers. A careful perusal convinces the reviewer that this is not an elementary text book on highway engineering, but is a book adapted to the use of engineers engaged in highway construction.

The author apparently makes an earnest effort to state the general problem of the highway engineer, and to attempt its solution. Mentioning first some of the high lights in the picture, the author cautions engineers of the danger of extravagance in the expenditure of public funds, especially when large sums are available. He sounds a note of warning regarding the use of standards which in effect he says are apt to be too closely followed to the detriment of the local problem.

Some features of the present condition in certain of the states are passed by, apparently because these conditions are not thoroughly understood. Most of the discussion regarding the grading and surfacing of highways has to do with localities where new roads are to be built which makes this work of more value for the engineer carrying on new construction than he who carries on reconstruction.

It is perhaps unfortunate that most of the detailed examples of highway construction are taken from New York State. It is not true, however, that the work is entirely based on New York State practice, but is particularly adaptable in certain instances to the solution of the general highway problem.

The book is divided into six chapters and an appendix. Chapter I takes up the general principles of economic highway design. In this chapter, the author, in pointing out the duty of the engineer to the community which he serves, sounds the usual note against politics, but brings out several new thoughts regarding the standing of the engineering profession in the community.

As to general principles, he stresses the need for highway mileage, but his conclusions may be questioned. In certain sections where traffic has developed in concentrated form, it seems impossible to lay down a rule for, or to determine the value of, road service. His statement that it is not necessary to worry about future traffic should be carefully considered in connection with the other matter in the book and not accepted alone. The paragraph on the demands of traffic is well founded on the principle that we should not build highways to carry a certain selected small number of vehicles. He lays down in this chapter eleven principles that point out the difficulties with which highway engineers are faced.

In the second chapter, which treats of proportion and economy in design, the author calls attention to several things necessary in the design of highways and highway structures which are not ordinarily considered by the engineer. He divides the subject between solutions for pioneer districts and those for more settled districts, which is a correct method of division. He also calls attention to the necessity for small savings which in the aggregate will reach large sums in a long period of time.

Chapter III, covering classification, routes and general engineering location, is quite unusual in its method of approach to the subject. The author appears to be sound in his conception of the value of traffic censuses, and also conservative in pointing out the necessity for making all possible modifications in results secured from traffic censuses on account of special causes, either for increase or decrease of traffic.

The author's discussion of highway financing, including the appendix, is valuable and should be in the mind of every engineer. The three principles of the distribution of tax burden are excellent. His chapter on this subject is generally sound. His treatment of selection of route is well done, and the chapter on general engineering location is a valuable addition to the literature on this subject. It seems unfortunate that the writer found it necessary to state that this work would not be of much interest to most of the younger engineers. It is exactly what the younger engineers need.

In the chapter on grades and alignment, which is, without doubt, the best portion of the book, the author goes into the selection of grades and the discussion of maxima and minima at length and with great care. It may be that a little too much consideration is given to the question of horse-drawn traffic, particularly for those sections where motor traffic is heavy.

The discussion upon selection of grades for motor truck traffic, while theoretical and to some extent beyond the power of the engineer to prove, opens up a new line of thought and will probably give rise to formulas which will be more possible of demonstration. The author has been courageous and in advance of his time in making up the tables of capitalization cost and the different grades illustrating these tables. His selection of examples to illustrate his argument is good. The few words on minimum grades are well selected, and what he says of alignment and sight distance is complete.

Chapter V on cross sections of rural roads is a compilation of information regarding road cross sections which is exceedingly full and complete. The discussion of the different features of this particular topic is admirable, and the collection of plates and tables showing the practices in different localities is valuable.

Chapter VI on drainage design does not seem as complete or satisfactory as the other chapters of the book. The discussion of rainfall, run-off and culvert area is good, though that upon values of different types of culverts is not as complete as one would like to have it.

The summary at the end of the chapter on drainage should have been enlarged to cover principles in the same manner as those on grades and alignment and cross sections of rural roads.

Concluding, the review of this book indicates that it is, as a whole, an excellent piece of work, and used with intelligence should do much to help the highway engineers of the different states in solving their great problems. The author is to be congratulated on his careful and painstaking consideration of the different topics involved. It is far easier to review and criticize than it is to write and complete a work of this kind. In the opinion of the writer this volume is an excellent piece of work attempting to bring the discussion of highway engineering up to the minute. The further volumes will be awaited with interest.

Walker's Building Estimator's Reference Book

THE BUILDING ESTIMATOR'S REFERENCE BOOK: A Practical and Thoroughly Reliable Book for Contractors and Estimators Engaged in Estimating the Cost of and Constructing all Classes of Modern Buildings, etc.—By Frank R. Walker, Assoc. M. Am. Soc. C.E., Author of "Practical Cost Keeping for Contractors". Fourth Edition. Chicago, Ill.: Frank R. Walker Co. Leatherette; 5 x 7 in.; pp. 2931; illustrated. $10.

The fact that this book has now gone into its fourth edition proves that it is having wide use. The latest edition is brought up to March 1, 1921, and contains matter of recent interest. The past three or four years, as the author well states, have played havoc with all cost estimates so that it is more than ever necessary to have revisions of such works as this. It is doubtful whether any revision could fully take care of the revolution in prices we have just gone through, but as Mr. Walker has in most cases included base rates the figures which he gives still have great use.

Omission of Author's Name

Unfortunately the signature of Joseph Kieran Costello, Detroit, Mich., was omitted from the letter entitled "Little Known Biographies of Engineers," appearing in this section, May 19, p. 863.

PUBLICATIONS RECEIVED

COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE—By Rudolph Hering, D.Sc., New York City; Past President of American Public Health Association and of Engineers Club of Philadelphia; Past Vice-President Am. Soc. C. E.; M.A.S.M.E., etc., and Samuel A. Greeley, Chicago, Ill., M. of American Public Health Association, M. Am. Soc. C. E., Western Society of Civil Engineers, M.A.A.E., etc. New York and London: McGraw-Hill Book Co., Inc. Paper; 6 x 9 in.; pp. 653; illustrated. $7.

CONNECTICUT INDUSTRIAL WASTE BOARD: Report 1918-20. Reprint from the Report of the State Department of Health, June 30, 1920—Hartford, Conn.: Department of Health. Paper; 6 x 9 in.; pp. 72.

DEVELOPMENT OF A SYSTEM OF FEDERAL GRANTS-IN-AID—By Paul H. Douglas. Reprinted from Political Science Quarterly, Dec., 1920. New York: Academy of Political Science. Paper; 6 x 9 in.; pp. 293.
Takes up aids for agriculture, post roads, vocational education, etc., and closes with an "evaluation" of the Federal aid system.

THE EFFICIENCY OF PUMPS AND EJECTORS—By E. C. Bowden-Smith, M. I. Mech. E., Late Egyptian Civil Service, Author of "Oil Firing for Kitchen Ranges and Steam Boilers," etc. New York: D. Van Nostrand Co. Cloth; 6 x 9 in.; pp. 205; illustrated. $5.

ENGINEERING CONSTRUCTION IN MASONRY AND CONCRETE: Part II—William Henry Warren, LL.D., Whitworth Scholar; M. Am. Soc. C. E., Challis Professor of Engineering and Dean of the Faculty of Engineering, University of Sydney, New York and London: Longmans, Green and Co. Cloth; 6 x 9 in.; pp. 498; illustrated. $12.

ENGINEERING ISTRUMENTS AND METERS—By Edgar A. Griffiths. New York: D. Van Nostrand Co. Cloth; 7 x 10 in.; pp. 360; illustrated. $7.50.

FACTS AND FIGURES OF THE AUTOMOBILE INDUSTRY: Statistics of Production, Registration, Export and Use of Motor Cars and Motor Trucks, 1921—New York: National Automobile Chamber of Commerce, Inc. Paper; 6 x 9 in.; pp. 96; illustrated.

THE GROUNDWORK OF ARCHITECTURE: Or the Study of How Architectural Styles Are Affected by Structural Engineering—By Emil G. Perrot, Registered Architect, M. Am. Soc. C. E., M. A.S.M.E., Philadelphia, Pa.: The Author. Paper; 7 x 10 in.; pp. 34; illustrated.

HOUSING BY EMPLOYERS IN THE UNITED STATES—By Leifur Magnusson. Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in; pp. 283; illustrated. 65c. from Superintendent of Documents.
Based on a country-wide survey, including various industries, made in 1916. Contains many valuable data.

THE LAY-OUT OF SMALL WATER MAINS: Notes and Tables Dealing with Various Problems in Simple, Compound, Double and Ring Mains—By H. H. Hellins, M.Inst.C.E. New York and London: Isaac Pitman & Sons. Cloth; 6 x 9 in.; pp. 45; illustrated. $3.

THE LUMBER INSPECTION RULES: Containing Rules Governing the Manufacture and Inspection of the Different Kinds of Lumber, Weights of Lumber, Comparative Strength of Building Timbers and other Information Useful to the Buyer and Consumer of Lumber—Compiled by Lumber Inspection Rules. Fourth Edition. New York: Lumber Inspection Rules, 280 Madison Ave. Leatherette; 4 x 6 in.; pp. 341; illustrated.

MAINTENANCE OF WAY CYCLOPEDIA: A Reference Book Covering Definitions, Descriptions, Illustrations and Methods of Use of the Materials, Equipment and Devices Employed in the Maintenance of the Tracks, Bridges, Buildings, Water Stations, Signals and Other Fixed Properties of Railways—Compiled and Edited by E. T. Howson, Western Editor of the *Railway Age*, and Editor of the *Railway Maintenance Engineer*, E. R. Lewis, Formerly Chief of the Duluth, South Shore & Atlantic, and K. E. Kellenberger (Signal Section), Editor of the *Railway Signal Engineer*, Assisted by Homer Hughes, Associate Editor, Formerly Assistant Field Engineer, Interstate Commerce Commission. In co-operation with the American Railway Engineering Association. New York: Simmons-Boardman Publishing Co. Cloth; 9 x 12 in.; pp. 860; illustrated. Cloth, $10; leather, $15.

NEW SOUTH WALES DEPARTMENT OF PUBLIC WORKS: Report, 1920—Sydney, New South Wales: The Department. Paper; 8 x 13 in.; pp. 101; illustrated.

NEW YORK STATE BARGE CANAL: Book of Plans Issued as a Supplement to the Annual Report of the Department of the State Engineer and Surveyor, Frank M. Williams, 1920—Albany, N. Y.: New York State Barge Canal, Department of State Engineer and Surveyor. Cloth; 19 x 13 in.; pp. 156; illustrated.

POPULATION DATA OF THE UNITED STATES: 1920 Census—Boston, Mass.: Arthur Perry & Co. Paper; 3 x 6 in.; pp. 44.
Gives 1920 and 1910 ppopulations of the 110 cities having over 65,000 population by 1920 Census, arranged from greatest to least; also populations for last four censuses, with increase by decades, for all places above 10,000 in 1920, arranged alphabetically, with ranking number.

POSITIONS IN THE CLASSIFIED SERVICE OF THE CITY OF PHILADELPHIA: Classification with Schedule of Compensation. Clinton Rogers Woodruff, Commissioner—Philadelphia, Pa.: Civil Service Commission. Paper; 6 x 9 in.; pp. 455.
Proposed classification under provisions of new charter, prepared by Griffenhagen and associates and approved by Philadelphia Civil Service Commission (but apparently not yet adopted by City Council). Contains specifications for various classes or grades of position, with titles and compensation.

RAINFALL AND RUNOFF IN THE MIAMI VALLEY—By Ivan E. Houk, District Hydrographer; Assoc. M. Am. Soc. C. E. Technical Reports, Part VIII, Miami Conservancy District. Dayton, Ohio: The District. Paper; 6 x 9 in.; pp. 234; illustrated. 75c.

RETAIL PRICES: 1913 to Dec., 1919—Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 497; illustrated.

SANITATION IN COUNTRY PLACES: The Theory and Practice Including the Bacteriolytic Tank System—By W. Ramsay Smith, M.D., DSc., F.R.S. (Edin.). Permanent Head of the Department of Public Health of South Australia; Fellow of the Royal Institute of Public Health of Great Britain, etc. Sixth Edition. Adelaide, Australia: The Author. Paper; 6 x 9 in.; pp. 40; illustrated.
The fifth edition was noted in these columns March 17, 1921, p. 477. Some new and later matter has been inserted in the present edition.

SHOP HANDBOOK ON ALLOY STEELS: A Technical Subject Treated in a Non-technical Way. By G. Van Dyke, Manager, Special Steel Dept., Joseph T. Ryerssson & Son. New York and Chicago: Joseph T. Ryerson & Son. Paper; 5 x 8 in.; pp. 95; illustrated.
Users of high-carbon and alloy steels will find this booklet interesting and instructive. The story of the production and manipulation of such steels is told in an easily understandable way, and in small compass a surprising amount of information on the make-up and peculiarities of special steel is imparted. There are also numerous tables of value for reference.

SIERRA LEONE RAILWAY: General Manager's Report on the Accounts and Working, 1919—Freetown, (Province of Sierra Leone) Africa: Railway Dept. Paper; 8 x 13 in.; pp. 48.

SOME ASPECTS OF THE GAUGE QUESTION—By F. G. Royal-Dawson, M. Inst. C. E., Chief Engineer with the Railway Board, Simla, India: Paper; 8 x 13 in.; pp. 36. 12 as.

STUDIES IN FRENCH FORESTRY—By Theodore S. Woolsey, Jr., Consulting Forester, Author of French Forests and Forestry (Tunisia, Algeria Corsica), and Executive Member Interallied War Timber Committee, Paris, 1917-19; with Two Chapters by William B. Greeley, Forester, U. S. Forest Service, and formerly Chief, Forestry Section C. and F., S. O. S., American Expeditionary Forces. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 550; illustrated. $6, postpaid.

WHOLESALE PRICES, 1890-1919. Washington, D. C.: Bureau of Labor Statistics. Paper; 6 x 9 in.; pp. 205; illustrated. 50c. from Superintendent of Documents.

LETTERS TO THE EDITOR

If you have ideas that would interest engineers and contractors we shall be glad to give them space here. We urge, however, that you be brief so that a wide range of subjects may be covered in the availabie space.—The Editor.

Hay as Filter for Boiler Water

Sir—In your issue of May 19, p. 869, appeared an interesting item concerning the "hay" filter used at Dayton, Ohio.

The writer, visiting a small water-works plant in Kansas some twenty-five years ago, saw a curious, cylindrical, orange-colored mass, somewhat suggestive of a mixture of macaroni, coral and calves brains. Upon inquiry it was found to be a bunch of hay that for some weeks had served in the plant's hot water heater for boiler supply.

It had been found to be an effective filter and depositary for calcareous contents of a very hard and sediment-carrying water. It was used until a more costly filtration plant restored hay to its normal use as an animal food.

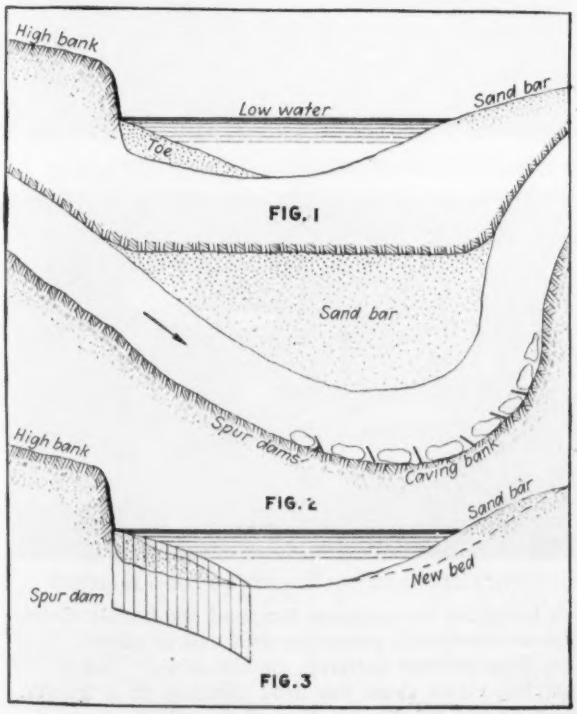
New York City, May 27. LOUIS L. TRIBUS,
Tribus & Massa, Consulting Engineers.

Protection of River Banks with Spur Dikes

Sir—The letter of Enrique Ramirez, *Engineering News-Record*, May 26, 1921, p. 909, in regard to spur dike river bank protection, recalls the installation that the writer saw several years ago in the Red River, Louisiana.

The caving banks of alluvial streams in this country have destroyed untold millions of dollars worth of property. A typical cross section of such a stream is shown in Fig. 1. The high bank with the nearly vertical face and the toe of loose material result from a cavein and which has not yet been washed away. To stop caving this toe below the low water line must be held in place and protected from high bank to channel center.

It has been found that any pile dike, built up to about the low water line and projecting at right angles to the stream or pointing down stream will usually cause a heavy scour around the outer end and along the upstream side, resulting in failure. It will also be a menace to navigation. Mattresses, rock fills, etc., laid on the toe soon break up or settle in the silt and are very expensive.



Accordingly the following method was employed. Spur dams were constructed as shown in Figs. 2 and 3. They pointed upstream at an angle of about 45 deg. They were made of a special dovetailed, interlocking sheet-piling built up of wood and concrete combined and jetted in place by a special marine piledriver. They extend from the low water line, projecting slightly above the toe, to the center of the channel where the top of the last piling is flush with the bed of the river.

By this method a substantial permanent structure is made and scour along the upper side and around the ends of the dams is prevented and navigation is not menaced. Bodies of dead water or very slow eddies are formed above, below and between the dams, causing the stream to drop its silt and further build up the toe. This dead water acts as a cushion, pushing the swift water path away from the caving bank.

In this type of construction it was found necessary to space the spur dams a distance apart equal to about one-fifth the radius of curvature of the river at that point. Piles must be non-buoyant or will work loose and float to the surface. Piling size and length vary under different conditions. The writer has seen interlocking piles 6 in. x 12 in. x 24 ft. placed with the tops flush with the river bed in 22 ft. of water and a five-mile current. This method is covered by patents in the United States.

Chicago, June 4. C. P. CHESTER.

Loose Anchor Bolts and Chimney Theory

Sir—Some time ago I examined a self-supporting steel chimney for a client who desired to purchase it. I noticed the top move what seemed to me 4 to 6 in. when the wind blew; its velocity that day was at times 45 miles an hour. The chimney was in a very exposed position. Imagine my surprise to find that the nuts on the anchor bolts had been loosened so that those I examined were ⅜ to ½ in. clear of the top of the bracket or lug which was riveted to the bell base of the chimney.

Why all the mathematical calculations of the necessary size and number of bolts, weight of foundation masonry, etc.? Here was a chimney 5 ft. in diameter and 118½ ft. high, resting upon a cast-iron base, and adjusting itself to as many new, nearly vertical positions as there were directions of the wind. The six 2¼-in. anchor bolts were set on a 10-ft. diameter pitch circle. Doubtless the designer thought necessary a 6-bolt anchorage, each bolt having some work to do, in fact one bolt at a time was doing all of the supporting or anchorage of the chimney.

This is another of the curious things one finds occasionally in the day's work. W. WALLACE CHRISTIE,
Ridgewood, N. J., June 4. Consulting Engineer.

Expressways for New York Traffic

Sir—I have been reading with a great deal of interest the discussion of Charles W. Leavitt's paper on "Expressways for New York Traffic" (see isue of March 31, p. 547) which has been going on in *Engineering News-Record*, particularly the comment by W. H. Breithaupt. I do not agree with him that it is necessary to put the expressways up so high above the street level, particularly as such a height would necessitate taking up too much room for the ramp approaches, whether they be spiral or otherwise.

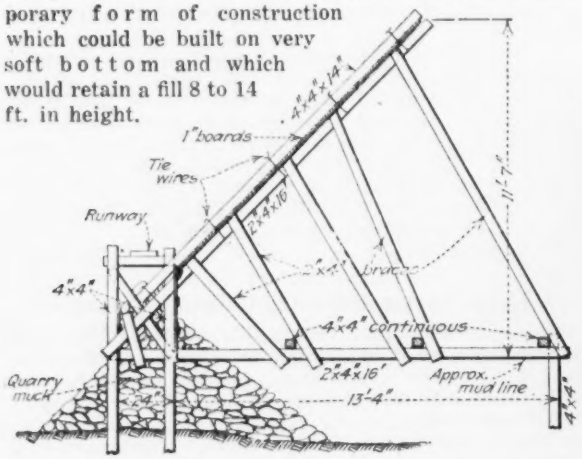
However, I have been wondering if you have considered the practicability of taking a strip of property, say 100 ft. wide, the entire length of the expressway, and using the space above, as well as below, for offices and apartments. Since the expressway itself need not be over 60 to 80 ft. wide, the remaining width could be used for corridors, elevator shafts and stairways to provide communication between the portions of the buildings below the expressway and the portions above it. CHARLES F. DINGMAN.

Palmer, Mass, May 28.

HINTS FOR THE CONTRACTOR

Effective Design for Wood Bulkhead To Hold Fill on Soft Bottom

A LIGHT timber bulkhead has been used successfully to retain a hydraulic fill in Los Angles harbor where several other types of retaining wall considered were found to be impracticable or too expensive. The fill is located on the north and west sides of the west basin. As a permanent wharf is to be built around this fill later, it was desirab'e to find some inexpensive temporary form of construction which could be built on very soft bottom and which would retain a fill 8 to 14 ft. in height.



CROSS-SECTION OF SEMI-FLEXIBLE BULKHEAD

The pair of 4 x 4-in. posts at the toe of the slope as well as the single line at the opposite end of the structure, were pushed down about 6 ft. into the soft mud of the bottom by hand, or where firmer soil was encountered were driven with a hand maul, the workmen using a boat part of the time and near shore working in ship boots at low tide. After the posts and main timbers were put in and the facing of 1-in. boards had been placed, barges of "quarry muck" were landed at high tide alongside the plank runway, the rock being taken in wheelbarrows 100 ft. each way from the barge and dumped to form a solid toe. Care was taken to use battens on a'l cracks between the 1-in. board facing.

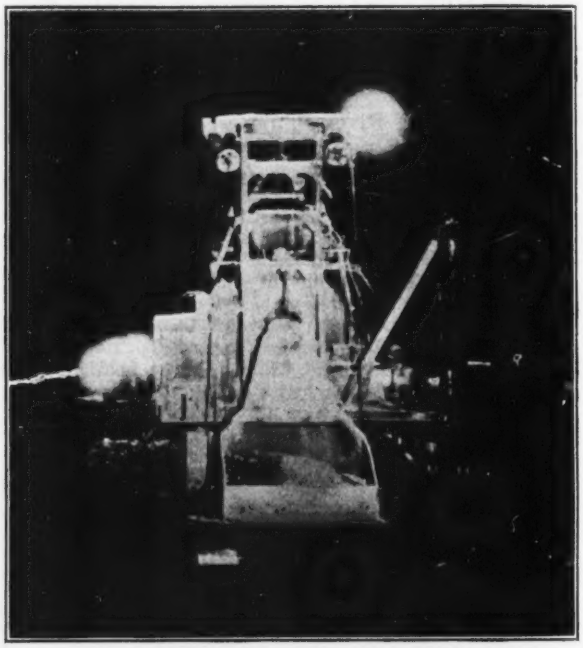
Bents, such as that shown in the cross-section, were placed every 4 ft. and thus boards whose lengths were any multiple of 4 could be used for the facing. The 45-deg. slope on the face was maintained throughout and the number of braces varied according to the height. The maximum height required was 14 ft. above the lower chord or horizontal 2 x 4 timber which was set on the surface of the mud.

This type of bulkhead was developed to meet the conditions imposed by the extreme instability of the soil. The idea was to obtain a bulkhead which could move laterally or vertically and still perform its function of impounding the discharge from a suction dredge. The rock toe is expected to prevent undercutting, the three longitudinal and continuous 4 x 4-in. anchors increase in effectiveness as the fill arises, and the shape of the structure is such that there is no tendency to overturn. In the softest places the bulkhead moved horizontally as much as 4 ft., at the same time settling more than 1½ ft., which, it is believed, would have destroyed most types of bulkhead.

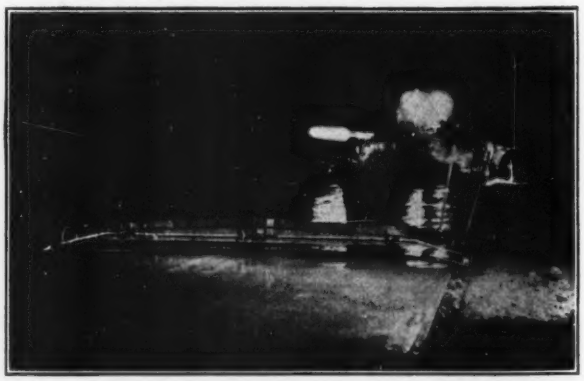
This design was prepared by J. Wyman Ludlow, assistant harbor engineer, Port of Los Angeles.

Night Lighting on Road Job

AS STATED in the article on the Maricopa County, Ariz., roads on p. 1026 of this issue, the concrete pavements there are being placed in two shifts, the latter of which runs from 6 p.m. to 2 a.m. After dark the job is lighted by acetylene lamps of the Carbic variety, placed at intervals along the road and by electric lighting, from storage batteries, on the mixer. The accompanying views show the flood lighting of a finishing machine and the illumination of the mixer.



MIXER LIGHTED BY STORAGE BATTERY LAMPS



CONCRETE TAMPING MACHINE FLOOD LIGHTED

NEWS OF THE WEEK

New York, June 16, 1921

To Standardize Water-Works Methods and Materials

Fifteen Committees Named at Cleveland Convention, Am. W. W. Assoc. —Bartow the New President

Fifteen committees to standardize water-works methods, materials, records and rules were announced by the council on standardization of the American Water Works Association at the forty-first annual convention held last week in Cleveland. The council, which was created a year ago and consists of George W. Fuller, chairman, Frank A. Barbour, Edward Bartow, George A. Johnson and George C. Whipple, has selected as secretary Malcom Pirnie, of Hazen, Whipple & Fuller, New York. The 1921-22 budget of the association includes an appropriation of $2,000 for the work of the council.

The attendance at the convention was unusually large; about 400 active members, besides many associates and guests, were registered. Nine papers descriptive of the Cleveland water-works were presented. There were two sessions for superintendents and one each for filter plant operators and for supply men. The chemical and bacterial section held two sessions.

In his valedictory, President Beekman C. Little, Rochester, N. Y., spoke for balanced membership, ranging from superintendents of the smallest works to the topmost engineers in the country. Besides having diverse knowledge the water-works manager must be a politician—of the better sort. He should conduct publicity and educational work. The association, President Little said, finds it impossible to meet its financial needs from dues alone and needs contributions.

New Officers

A canvass of the letter ballot showed the following officers for 1921-22: President, Prof. Edward Bartow, Ames, Iowa; vice-president, W. S. Cramer, Lexington, Ky.; treasurer, W. W. Brush, New York City; trustees, G. C. Gensheimer, Erie, Pa., and J. C. Jensen, Council Bluffs, Iowa. There was no opposition ticket.

(Continued on p. 1053)

Delaware River Bridge To Be Suspension Structure

Board of Engineers Selects Location At Franklin Square—Bridge To Cost $29,000,000

Basing on studies continued for nearly nine months, the Board of Engineers on the Delaware River bridge reported to the joint interstate bridge commissions of New Jersey and Pennsylvania on June 9 on best location, type of structure, and cost of a highway connection between Philadelphia and Camden. It recommends a location about half a mile north of Market St., Philadelphia, extending from a western terminus at Franklin Square on Sixth St. between Race and Vine Sts., southeasterly at right angles to the river to an eastern terminus near Fifth and Linden Sts. in Camden. A suspension bridge with single highway deck and elevated footwalks was found to be the most desirable type of structure. The bridge will have a main span of 1,750 ft. and loaded side spans of 719 ft., flanked by viaduct and filled approaches. Its clearance height will be 135 ft. above

ARCHITECT'S SKETCH OF BRIDGE TOWER

(Continued on p. 1052)

Pueblo Flood Intensified by Dam Failure

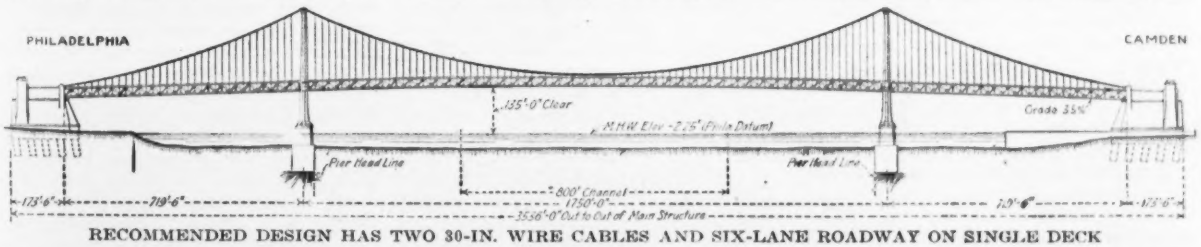
Earth Dam on Beaver Creek Washed Out—Levees Overtopped—Bridge Damage Not General

Reports on the effects of the Pueblo flood sent by a special correspondent of *Engineering News-Record* after a most difficult tour of several days through the flood district indicate that the destruction and damage in Pueblo is not as serious as first reports indicated, and that bridge and road washouts in the river valleys are not general and can be repaired for temporary service in a very short time.

Typical views of the flooded portions of Pueblo are shown on the opposite page. The greater part of the damage in the city appears to be chargeable to submergence and the attendant influx of mud and debris. Failure of the levees at several points and diversion of the river flow through parts of its original winding channel, straightened thirty or forty years ago, are responsible for more destructive local effects.

Bridge destruction was far from general. The old street bridges in the center of the city (see views) were not washed out, whereas in the downstream part of the city one railroad bridge was washed out, together with a highway bridge close alongside, while another railroad bridge paralleling the first remained standing. On Fountain Creek also one railroad bridge was destroyed. All the failures observed were caused by abutment or pier washouts, and no material amount of destruction by impact of current and floating debris was noticed.

The unprecedented height of the flood at Pueblo was due to the combined effect of a series of cloudburst-like rainfalls above the city and the washing out of the Schaefer dam of the Beaver Park Land & Irrigation Co. on Beaver Creek, about 40 miles northwest. This occurred at the peak of the rainfall flood, on the morning of June 5. The location of the city on the low ground at the junction of the Arkansas River and Fountain Creek was an essential factor in ponding the water. The Arkansas River flows southeasterly



RECOMMENDED DESIGN HAS TWO 30-IN. WIRE CABLES AND SIX-LANE ROADWAY ON SINGLE DECK

through Pueblo in a valley one-quarter to one-half mile wide and originally meandering through the valley bottom. Fountain Creek joins it from the north just below the city. In the heart of Pueblo most of the bottom land is south of the river, being bounded by an abrupt slope to a bench or mesa on which much of the newer residential portion of the city is located. The destruction was confined to the low area, including the extensive railroad yards of the Santa Fe, the Denver & Rio Grande and Missouri Pacific lines, the Union Station, business and industrial districts and the like.

Early in the rise of the Arkansas the river overflowed the levees of lead-smelter slag blocks and granite facing that confined the rectified channel, and swept in a fan out into the business and downtown districts, which it ultimately flooded 15 ft. deep. Washing out of the levees occurred at a few points, as at the south end of the Santa Fe bridge —the K-truss structure shown in two of the views—whence the water flowed in a southerly loop along a part of the original river channel.

By the submergence and the current through the city, wooden houses were floated and smashed against more resistant structures, in turn causing many of the more substantial buildings to collapse. Fire that started in the lumber yards added to the danger at the height of the flood, but it was brought under control largely with the aid of the continuing rain. As has already been reported by press dispatches substantially correctly, about 350 city blocks have been wholly or partly ruined, and more than 50 large business buildings damaged by water or fire. Generally speaking frame buildings were utterly destroyed, while substantial brick wall construction of 13-in. thickness resisted in gratifying manner. A big concrete grain elevator, which for a day or two stood in a sea of mud and water, proved to be undamaged when the flood receded.

Breakage of water mains and local blocking of the sewers added to the difficulties of existence in the flooded district. Gas and electric light remained in service, partly at least, in residential districts above flood level.

Two strenuous attempts made by the correspondent to reach the washed-out Schaefer dam failed, passage being effectively blocked by bridge destruction. According to an eye-witness at Beaver, the flood wave which rushed down the canyon on failure of the dam formed a bore 20 ft. high and 600 ft. wide, in which rocks up to a cubic yard in size were carried along. Cottonwood trees were marked 30 ft. high with debris.

However, the Schaefer dam and a few very small earth dams are the only failures of this class of structure in the Colorado storm district, in spite of the general distribution of the flood rainfall over a large part of the Eastern Slope. The Skagway dam, previously reported to have failed, is still in place; its steel-plate-faced rock-fill structure seems to have resisted the flood effects successfully.

The Schaefer dam, 90 ft. high, was originally designed as a hydraulic-fill structure, under O. K. Parker. Subsequently team and scraper fill construction was advised by the late T. O. Jaycox, then state engineer. A study of its destruction has not been possible, as indicated, but the probabilities are that inadequate spillway capacity and cutting of the downstream slope by overflow were responsible for the washout.

Dowell Bill Strengthened by House Committee's Action

(Washington Correspondence)

Friends of the Dowell road bill are much elated over the strategy practised by the committee on roads of the House in attaching the Dowell bill, as amended, to the Phipps bill. The Phipps bill, which provides for an extension of time to the states that have been unable to absorb all the federal-aid money during the current year, already has passed the Senate. This has the effect of throwing the Phipps bill, with the Dowell rider, into conference, once that the measure has passed the House. While Senator Townsend may devise some means of delaying action, it is admitted that a very decided advantage has been gained by the proponents of the Dowell bill. Great pressure in favor of the Phipps bill will be brought by the states that have not absorbed their quota of federal funds, for if the Phipps bill does not become a law before July 1 the unabsorbed portion of the fund will be returned to the Treasury.

The present plan is for the House to bring up the Phipps bill on June 20. To do so will require a suspension of the rules, which calls for a two-thirds vote.

Minor Amendments Only

The only major amendment made to the Dowell bill by the House committee was in the provision regarding roads in the forest reserves. The amendment provides that 50 per cent of funds thus expended must be used in connecting main roads. The notice as to maintenance was increased from 60 to 100 days.

Hearings on the Dowell bill before the House committee covered much the same ground as did the hearings before the Senate committee. Witnesses appearing before the committee were unanimous that a prompt determination of the federal government's policy is necessary to the effective carrying forward of the state and county programs.

Thomas H. MacDonald, Chief of the Bureau of Public Roads, urged among other things that the bill should give authority for the federal government to train men for highway work. His suggestion is that this training should be confined to graduate engineers who would be glad to accept nominal salaries in order to get the advantage of the instruction and actual practice which the government could offer.

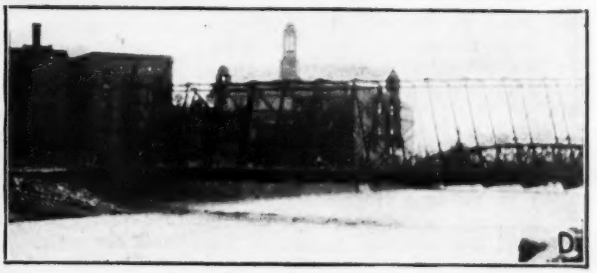
Senator Phipps, of Colorado, told the House committee that federal aid now represents only one-tenth of the amount expended on highways and for that reason he believes that the point has not been reached where federal maintenance should be given consideration. The time will come, he declared, when it must be considered.

New Yorkers Continue to Fight Passaic Valley Sewerage

The committee on pollution and sewerage of the Merchants Association of New York, which has been the moving spirit in the effort to prevent the Passaic Valley sewage being disposed of in New York Bay, has returned to the attack following the decision of the United States Supreme Court noted in these pages May 19, p. 849. In a report to the association the committee contends that the stipulations laid down by the Supreme Court are impossible of determination. Particularly it objects to the clauses which say that there shall be absence in the New York Bay and its vicinity of odor due to putrefaction of organic matters contained in the *Passaic Valley* sewage thus discharged. It claims that it will be impossible to determine if there is pollution whether it is due to Passaic Valley sewage or any of the other sewage being dumped into the harbor from various sources. The committee states "The health of over 10,000,000 people in this metropolitan district is threatened by the liquid filth that would surround us, and we should not have to wait until a great menace confronts us when pestilence and death may claim thousands of our citizens to obtain technical legal evidence."

The committee therefore recommended that it be authorized to endeavor to secure the appointment by the War Department of a competent sanitary engineer who shall be required to make frequent inspections, examinations, and analyses of the harbor at various typical points, and to make a full and complete report of the same. Further, it recommended that a taxpayers' suit be brought in New Jersey to restrain the expenditure of the amount needed to complete the Passaic Valley sewerage system on the ground that such expenditure has been rendered unnecessary by the Supreme Court's stipulations. These guarantee the elimination from the sewage of deleterious matter to such an extent that the outflow from the sewer may be located in Newark Bay, thus rendering further extensions of the sewer unnecessary, according to the committee.

The directors did not approve the second suggestion, but asked the committee to establish contact with the New Jersey State Chamber of Commerce and other commercial organizations in New York City with a view of enlisting their aid in the modification of the plan, which would make the construction of the outlet sewer from Newark Bay to New York Harbor unnecessary.



Pueblo Flood Impressions

A—Passenger trains overturned at Union Station. Station roof in right foreground, Main and Union Ave. viaducts at left. (C. Underwood & Underwood.)

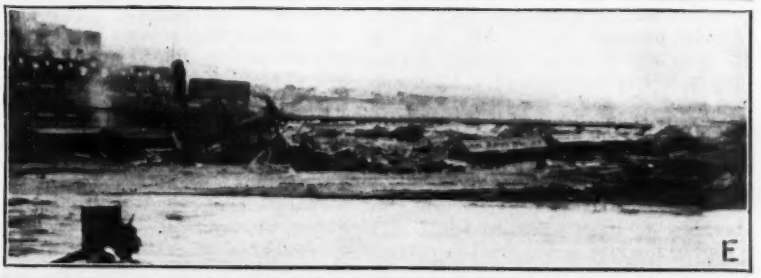
B—Concrete grain elevator undamaged.

C—A. T. & S. F. Ry. bridge over Arkansas River, with wrecked railway bridge alongside. Santa Fe Ave. bridge destroyed.

D—Victoria Ave. bridge, center of Pueblo; Union Ave. bridge in background.

E—Looking southwest at C Street viaduct over railway yards.

F—Airplane view north along Santa Fe Ave. (C. Underwood & Underwood.)



Arkansas Road Law Declared Invalid by Supreme Court

In a unanimous decision handed down June 6 the U. S. Supreme Court, reversing the judgment of the State courts, has declared invalid the Arkansas road law under which local improvement districts have been formed and property within them taxed to pay for the "benefits" derived. The case was that of the Kansas City Southern Ry. Co. and the Texarkana & Fort Smith Ry. Co. vs. Road Improvement District No. 6 in Little River County. Assessments amounting to $67,900, amounting to $7,000 per mile of track for 9.7 miles within the taxable zone, were demanded from the railroads by the road commissioners for the construction of a gravel road 11.2 miles long.

The Supreme Court decision, delivered by associate Justice McReynolds, declares that "the statute under consideration prescribed no definite standard for determining benefits upon proposed improvements," and that in this case, which the Arkansas courts had held to be within the law and valid, "we think the discrimination so palpable and arbitrary as to amount to a denial of the equal protection of the law."

Taxes on Zone Basis

"They divided the farming lands into five zones," the decision says, "determined by distance from the highways and assessed uniform benefits within the same zone without regard to improvements or market value."

"Town lots," the decision adds, "were likewise assessed at $10, $15, $20 and $25 each, according to location. A pipe line, a telephone line and a telegraph line were severally assessed at $2,500, $300 and $200 per mile without any designated basis."

"Benefits from local improvements" according to the Supreme Court, "must be estimated upon contiguous property according to some standard which will probably produce approximately correct general results. To say that 9.7 miles of railroad in a purely farming section, treated as an aliquot part of the whole system, will receive benefits amounting to $67,000 from the construction of 11.2 miles of gravel road seems wholly improbable, if not impossible. Equal protection of the law must be extended to all."

The decision concludes with this instruction to the Supreme Court of Arkansas:

"The judgment of the court below is reversed and the cause remanded for further proceedings not inconsistent with this opinion."

Stoughton Resigns Secretaryship

The board of directors of the American Institute of Mining and Metallurgical Engineers has accepted with regret the resignation, after eight years of service, of Bradley Stoughton as secretary, and has put upon record its appreciation of his long and efficient service.

Delaware River Bridge

(Continued from p. 1049)

mean high water for a width of 800 ft., and the gradients of the roadway on either side will be 3½ per cent. The cost of this structure including real estate is estimated at $28,871,000.

These recommendations were based on studies of traffic distribution (including origin and destination), core borings to determine the depth to rock at five different sites distributed over about two miles length of the river, and comparative designs and estimates of bridge structures. These studies showed that the center of population, the center of location of industries, and the center of cross-river vehicle traffic in Philadelphia lie north of Market St., that rock foundations are available at all of the sites considered at depths of 70 to about 120 ft., with least depth (80 to 90 ft.) at the Franklin Square site, that spans of 1,750 to 1,800 ft. would be required if no obstructions between pier-head lines are permitted, and that the cost would range from $29,000,000 for the Franklin Square location to $39,000,000 for a location at Washingon Square (south of Market St.).

A ruling as to the required vertical clearance was obtained from the War Department after hearings before Major L. E. Lyon, U. S. Engineer Officer, and consideration of the case by the Chief of Engineers. It was shown by the engineers of the Bridge Commission that all navigation needs would be satisfied by a clearance of 135 ft. above mean high water, and the Board's request for approval of a plan that would provide this clearance height for a width of 800 ft. and would not obstruct the channel between pier-head lines was granted.

On account of the narrowness of the Philadelphia streets a certain amount of street widening is necessary at the Philadelphia end. Sixth St. is to be widened from Market St. north to Spring Garden St., Vine St. from Sixth St. to Broad St., and Ridge Ave. running northwesterly from Vine St. to Broad St., to widths of about 80 ft. For future construction the widening of streets forming a traffic circuit around the Philadelphia business district is recommended, in conformity with prior recommendations by a city planning committee. On the Camden side of the river a short length of new street running southeastward is projected.

The structure designed by the board provides six vehicle lanes by means of a single roadway 57 ft. wide between curbs. To either side of this roadway there is provision for a street-car track, and outside the line of the cables a rapid transit track. The two parallel-wire suspension cables, each 30 in. in diameter, are 89 ft. apart, while the out-to-out length of floorbeam is 122½ ft. Stiffening trusses 28 ft. deep, continuous between towers, provide for distributing load concentrations. The type of structure is notable for having the cables anchored to the tops of the column towers, the relative movement of main and side spans being compensated for by bending of the towers.

Public hearings on the recommendations of the board of engineers will be held by the Joint Bridge Commissions within the current week, with a view to making it possible to arrive at a decision concerning the adoption of the board's recommendations before the end of the month. If work is begun without delay, the board states, the bridge can be built by July 4, 1926, the sesquicentennial of the Declaration of Independence.

The board of engineers consists of George S. Webster, chairman; Ralph Modjeski, and Laurence A. Ball. Clement E. Chase is principal assistant engineer. L. S. Moisseiff is consulting designing engineer, Paul P. Cret is architect, and Arnold W. Brunner is consulting architect.

Alaskans Ask Harding to Appoint New Railroad Commission

President Harding has been memorialized by the Chamber of Commerce of Seward, Alaska, to appoint a new commission to take over the construction of the Alaskan Railroad, being carried out by the Alaskan Engineering Commission. It is charged that there has been undue delay and wastefulness in completing the work; that while the work has already run for more than six years, private contractors at one time agreed to complete it within eighteen months. The President is asked to appoint "a practical railroad builder."

800 Present at Ridgway Dinner

About 800 engineers and contractors of the metropolitan district attended a dinner at the Hotel Pennsylvania, New York City, June 9, as a testimonial to Robert Ridgway on his recent promotion to the position of chief engineer of the New York Transit Commission. Engineers and contractors, old and young, in the city's service and in private practice, constituted a gathering unique in point of size and representative character.

J. Waldo Smith, chief engineer of the New York Board of Water Supply, acted as toastmaster and the principal speaker was the Hon. George McAneny, newly appointed chairman of the Transit Commission, who paid an eloquent tribute to the technical and personal qualifications of the commission's new chief engineer. Among the other speakers were John H. Delaney, former Transit Construction Commissioner, Judge Edward E. McCall, former public service commissioner, Major-Gen. O'Ryan, who commanded the 27th Division of the A.E.F. in France, Col. William Barclay Parsons, consulting engineer and the first chief engineer of the New York subway work, and John F. Galvin, Catskill Aqueduct commissioner. Mr. Ridgway concluded the program with an expression of thanks for the honor shown him.

The arrangements for the dinner were in the hands of W. J. Buhrendorf.

Water Works Convention

(Continued from p. 1049)

The new executive committee reappointed John M. Diven as secretary and named a new publication committee, including Prof. John H. Gregory and Abel Wolman, both of Baltimore, Md., as chairman and editor. The old finance committee was replaced by George C. Andrews, Buffalo, chairman; C. R. Henderson and J. W. Ackerman.

Officers nominated for 1922-23 were: President, W. S Cramer; vice-president, George W. Fuller; treasurer, W. W. Brush; trustees, George W. Batchelder and J. W. Ellms.

Finances—The retiring finance committee, George A. Johnson, chairman, reported a deficit for the year of $2,009, met from the reserve fund. A budget of $18,000 was announced; $1,255, it is estimated, will have to come from the reserve fund unless there is a successful drive for new members. The reserve fund now stands at $12,000 par value of $11,000 market value of the securities, mostly Liberty Bonds.

Subject to final action by the executive committee, Philadelphia was chosen as the meeting place of the 1922 convention.

Standardization Committees

In presenting its report, the council on standardization announced that the various committees will submit for approval by the association a program of the work contemplated. The committees were urged to conduct research and practical work simultaneously, so that water-works operators may benefit from the activities at an early date.

Besides the investigations to be made by the standardization committees, the council proposes to secure brief abstracts of reports and papers of interest to members, paying younger members a half cent a word for the work and printing the abstracts in the *Journal* of the association. The council has appointed the following committee on abstracts, to report by Sept. 15: A. L. Fales, of Metcalf & Eddy, Boston, J. N. Chester, F. C. Jordan, R. S. Weston and Abel Wolman.

The 15 standardization and research committees, with the names of their chairmen, are as follows:

Water Analysis, Jack J. Hinman, Jr., Iowa City; Drinking Water, A. W. Freeman, Columbus; Load Factors for Purification Plants, E. E. Wall, St. Louis; Colloid Chemistry, R. S. Weston, Boston; Watershed Protection, T. De L. Coffin, New York; Industrial Wastes, A. L. Fales, Boston; Pumping Station Betterments, Leonard A. Day, St. Louis; Distribution Systems, G. G. Dixon, Akron, Ohio; Services, J. M. Diven, New York; Sanitary Fountains, J. H. Dunlap, Iowa City; Testing Water-Works Materials, John H. Gregory, Baltimore; Water Waste Control, W. W. Brush, New York; Meter Schedules, Allen Hazen, New York; Relations Between Water-Works and Consumers, F. C. Jordan, Indianapolis; Water Department Records and Reports, (municipal plants) George H. Fenkell, Detroit, Mich.; (privately owned plants) John N. Chester, Pittsburgh, Pa.

Aside from the council on standardization, and apparently due to changes caused by its creation, the standing technical committees reported little but "progress," with the notable exception of the committee on standard specifications for water meters, C. M. Saville, Hartford, Conn., chairman. The report of this committee, with full specifications, (see *Journal* of the Association for May, 1921) was adopted by the convention.

Real although slow progress was also reported for the committee on standard specifications for cast-iron pipe, F. A. Barbour, Boston, chairman. This committee, created ten years ago, and working in co-operation with a joint committee of the New England Water-Works Association, presented tentative revised joint specifications in 1917, but without the co-operation of the manufacturer members of the committee. This check, combined with war and post-war conditions, has prevented much further progress, and the committee reported that it does not yet seem opportune to attempt rapid progress. Present indications, after correspondence with a number of pipe-users and taking into account the attitude of the pipe makers, are that the proposals for uniform pipe diameter and for changes in chemical composition of pipe will be given up or postponed. Arrangements for flexure tests to throw light on chemical composition have been made with Dr. Molderke by the pipe manufacturers. It is hoped that a way may be found to make studies of pipe coatings.

Bacterial and Chemical Section

At the meetings of the bacterial and chemical section the subjects nearly all bore on collodial chemistry and its various ramifications into the field of water chemistry. An operators' section, similar to the laboratory section, will probably be formed by next year. Discussions were live and directed mainly toward the appraisement of the new electrical neutrality methods as applied to coagulation and filtration. The newly elected officers of the section are: Chairman, Allen Hazen; secretary, J. J. Hinman, Jr.; executive committee, L. H. Enslow, H. E. Jordan, W. M. Clark, N. J. Howard, M. F. Stein, A. M. Baswell, Warren Hatfield.

Manufacturers Have Floor

An innovation at this convention was an evening program of papers by supply men, arranged by the Water-Works Manufacturers Association. Charles H. Ade, National Meter Co., under the title, "Water Supply from the Supply Men's Viewpoint," amused those present by random reflections on men and things in and near the water-works field. Peter P. Dean, Cutler-Hammer Manufacturing Co., told of the development and application of electrical operation and control of valves. F. B. Leopold, Pittsburgh Filter & Engineering Co., recited his experiences in developing an oil engine. R. K. Blanchard, Neptune Meter Co., New York City, reviewed the work of the American, the New England and the Manufacturers' Water Works Associations in standardizing meters and meter specifications. Incidentally, Mr. Blanchard stated that statistics obtained from the makers showed that the number of water meters in use was about 4,400 in 1880 and 8,450,000 in 1920.

Some of the convention papers and discussions will be found abstracted elsewhere in this and succeeding issues.

May Build $25,000,000 Bridge Across San Francisco Bay

The San Francisco real estate firm of A. J. Rich & Co. announces in the San Francisco daily press that it has arranged for the necessary capital with which to construct a $25,000,000 bridge from Candlestick Point near South San Francisco (about 6 miles in an air line south of the Ferry Building), to a corresponding point on the Alameda side of the bay. This would be a real estate devolpment scheme, contemplating the development of large areas of land near each terminal of the bridge. The bridge plans, it is stated, were prepared by Gustav Lindenthal of New York. The structure would be designed for steam and electric lines, as well as for vehicular traffic, and would have a bascule span to permit the passage of shipping. The construction is estimated to require three to four years. The approval of the War Department has not yet been secured.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY FOR TESTING MATERIALS. Philadelphia; Annual meeting, Asbury Park, N. J., June 20-24.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION. University of Pittsburgh, Pittsburgh, Pa.; Annual Convention, New Haven, Conn., June 28-July 1.

The Providence (R. I.) Engineering Society has abandoned its project for the purchase and use of the rectory of St. John's Church as a club house, according to information received from City Engineer M. H. Bronsdon, chairman of the committee on rooms. The committee is now investigating other prospects.

The Society of Terminal Engineers, at a meeting held May 10 in New York, elected the following officers: President, R. H. McLain; vice-presidents, B. F. Cresson, Jr., Maurice W. Williams, M. A. Long and Charles C. Hurlbut; treasurer, W. J. Barney; secretary, J. H. Leonard.

PERSONAL NOTES

T. M. BREWER has been appointed city engineer of Viroqua, Wis.

AUGUST E. KRINGEL has been appointed city engineer of Green Bay, Wis.

W. W. REED, formerly city engineer of Green Bay, Wis., has opened an office in Green Bay to engage in consulting engineering practice.

G. M. BRAUNE, professor of civil engineering and head of the civil engineering department, University of Cincinnati, has resigned effective Aug. 1, to become head of the civil engineering department of the University of North Carolina. Mr. Braune was engineer with the Southern Bridge Co., Birmingham, Ala., for five years and was for over five years connected with the New York State Barge Canal, part of which time he was assistant chief bridge designer. He has been connected with the University of Cincinnati since 1912.

FRIEND P. WILLIAMS, special deputy state engineer, New York, and formerly division engineer, western division, New York State Barge Canal, with headquarters in Rochester, N. Y., has been appointed secretary of the New York State Water Power Commission, which was established by the last session of the legislature to make an investigation into the water power of the state. Mr. Williams is a Cornell graduate, class of 1899, and has been in the state service since 1904.

MARSHALL G. FINDLEY, who for some years has been assistant designing engineer to the board of commissioners of the Port of New Orleans, has taken a position as engineer with Villadsen Bros., Inc., engineers and contractors, Salt Lake City.

JOSEPH Y. L. REID, for some time chemist and engineer for the Du Pont Co., Wilmington, Del., has been appointed by the city commission as superintendent of the Trenton, N. J., filtration plant, to succeed F. W. Daggett, deceased.

CHARLES M. UPHAM, state highway engineer of Delaware, has been granted a year's leave of absence beginning Sept. 1 to accept the position of chief engineer of the state highway department of North Carolina, which recently approved a $50,000,000 bond issue for road improvements.

ROSS J. BUCK, director of public works and city engineer of Muskegon, Mich., calls attention to an erroneous statement in this journal May 19, naming John B. Fik as city engineer. Mr. Buck is the city engineer.

COLONEL WASHINGTON A. ROEBLING has been elected president of the John A. Roebling's Sons Co. to fill the vacancy caused by the death of Karl G. Roebling.

GEORGE S. IREDELL, civil engineer and landscape designer, has moved from his former location in Austin, Tex., where he has been engaged in engineering and landscape designing for about fifteen years, and where he served as city engineer for a number of years, and has established offices in Tampa, Fla., where he will specialize in municipal, subdivision, landscape engineering, and city development.

B. E. CLARK, acting state engineer and also acting state highway commissioner of Oklahoma, has been appointed state highway commissioner of Oklahoma by Governor Robertson. He was graduated from Washington and Lee University as a mining and civil engineer in 1906. He then engaged in construction work for the Nebo Consolidated Coal & Coke Co. in Kentucky on railway and mining development and later held the office of county engineer for Pittsburgh, Coal, Choctaw and McCurtain counties, Okla. He entered the service of the State of Oklahoma as district highway engineer and was in charge of the federal aid projects.

FRANKLIN R. MCMILLAN, formerly with Turner Construction Co., New York, has become associated with Shenehon & Meyer, consulting engineers, Minneapolis. Mr. McMillan for some years was engaged in railroad work, and in the construction of irrigation works for the U. S. Reclamation Service. Prior to 1917 he was assistant professor of structural engineering, University of Minnesota, in charge of design and laboratory investigations in concrete and reinforced concrete. During this period and since that time he has specialized in concrete and reinforced concrete. During the war he was research engineer for the Emergency Fleet Corp., in charge of the investigation of stresses in concrete ships. In this work he developed the strainagraph, a recording strain gage which was used in obtaining stress records for both steel and concrete ships in service and during launching. While with the Turner Construction Co. he was largely concerned with special problems in design and in the study of concrete aggregates and mixtures.

ALEXANDER P. GEST, secretary of the Association of Transportation Officers of the Pennsylvania R.R., was relieved from active service on April 1 and placed on the company's "Roll of Honor" after 45 years of service. Among his assignments were division engineer of the Monongahela, the Pittsburgh and the New York divisions, from 1883 to 1886. In 1912 he became special agent of the New Jersey division and was promoted three years later to the staff of the general manager.

FREDERICK C. HORNER, for several years transportation engineer of the Packard Motor Car Co., New York, is leaving the company to spend two years in Europe on a study of transportation practice in England, France, Belgium and Germany. He will sail from New York July 2.

BUSINESS NOTES

RALPH S. COOPER, in addition to being vice-president and general sales manager of the Independent Pneumatic Tool Co., Chicago, Ill., has been appointed general manager. He recently returned from Europe, where he had been for eight months establishing branch offices of the company.

HAROLD B. WOOD has been placed in charge of the New York office of the Jeffrey Manufacturing Co., Columbus, Ohio, as district manager.

THE CLYDE IRON WORKS SALES CO., Duluth, Minn., has announced three new agency connections in the Eastern portion of the United States. These are Edelen & Co., Philadelphia, Pa.; Queen City Supply Co., Cincinnati, Ohio, and Waldo Bros. & Bond Co., Boston, Mass.

THE LUDOLF M. HANSEN CO., designers and contractors, Green Bay, Wis., have added road construction and structural steel work, especially bridge construction, to its present activities. This work will be in charge of F. A. Torkelson, formerly city engineer of Green Bay.

THE HARRY M. HOPE ENGINEERING CO., of Boston, has established offices in Montreal to handle its Canadian business. George W. Saunders, formerly with S. Pearson & Son, London, is Canadian manager.

OBITUARY

HENRY B. LEDYARD, chairman of the board of directors of the Michigan Central R.R., died May 25. He was born in Paris, France, and was graduated from West Point in 1865. For two years he was chief engineer of the Michigan Central R.R. He later became general superintendent and then general manager. In 1883 he became president of the Michigan Central Lines.

WILLIAM B. COGSWELL, civil engineer and founder of the Solvay Process Co., Syracuse, N. Y., died June 8, in Brooklyn, N. Y. He was born in Oswego, N. Y., in 1834 and was a graduate of Rensselaer Polytechnic Institute. In 1856 he was appointed assistant superintendent of the Marietta & Cincinnati R.R. and from 1861 to 1865 he was in the United States Navy. In 1862 he had charge of the steam repair and construction work in the Brooklyn Navy Yard. In 1869 he was engaged in erecting the Frankin Iron Works in Oneida County and in 1861 established the Solvay Process Co., chemical works for soda products.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Federal Trade Commission Cites West Coast Lumbermen

Price fixing and artificial curtailment of production are charged by inference in a report issued to Congress by the Federal Trade Commission, June 9, 1921, on the West Coast Lumbermen's Association. Some of the subjects treated in the report are: "Present Activities," "Restriction of Production," "Co-operation Between West Coast Lumbermen's Association and Western Pine Manufacturers Association," "Price and Curtailment of Production Activities of Loggers' Associations."

The Federal Trade Commission does not recommend legislation in the report, but it is intimated that action is expected on the part of the Department of Justice. The West Coast Lumbermen's Association has replied that it has not since the war attempted to fix prices nor has it attempted to curtail output as charged in the commission's report. It states that during the war period it did fix prices in conjunction with the War Industries Board at the request of the government and during this period it endeavored to curtail non-essential production in order to stimulate essential war production. The association also calls attention to the recent 33⅓ per cent increase in rail freight rates applied to the long haul to the eastern markets, which "disrupted competitive rate relationships of thirty years' standing, by greatly increasing the transcontinental haul to eastern markets as compared with rates to those markets from short-haul producing regions."

Bridge Plans in Indiana Involve Cost Exceeding $1,000,000

According to a recent estimate made by W. J. Titus, head of the bridge department of the Indiana State Highway Commission, between $1,000,000 and $1,500,000 will be expended this year on bridge construction. It is estimated that thirty-eight contracts will be awarded by the bridge department within the next month.

U. S. District Court To Take Up Building Combine Probe

Col. William Hayward, recently designated U. S. District Attorney for the Southern District of New York, is co-operating with the Lockwood committee in its housing investigation. It is understood the Federal court will digest the evidence adduced during the Lockwood hearings as a preliminary to a possible prosecution of a score of building combines of a national character, capitalized for an approximate total of $2,000,000.

Wages and the Cost of Living

Relation Between Wholesale and Retail Prices Shown—Actual Decline in Living Cost Established

In order not only to understand the trend of wages, but also to be in a position to estimate approximately at what level wages are likely to be at a given time in the near future, a study must be made of the cost of living. Of course there are other factors than the cost of living that determine wages: The strength or disorganization of unions, immigration, export demand for products, general prosperity of the country as reflected in buying volume, and the margin of profit on which general industry is functioning. The matter of profit is really tied up with the general prosperity factor, for with a rising market and plenty of money, the margin of profit expands. It is at such a time that labor, whether plentiful or scarce, is more liberally paid. At the same time the very prosperity of industry, and consequently of the country, raises the cost of living, which therefore is, after all, the basic factor in adjusting wages.

To read the trend of living cost, it is necessary to study both wholesale and retail prices. The cost of living is of course the immediate reflection of consumers' prices, which usually lag behind movement in the wholesale market. Wholesale prices, however, do eventually affect the cost of living. Fig. 1 gives an idea of the extent to which the wholesale and retail curves are out of phase. The upper curve is the *Annalist* index number, showing fluctuations in the average wholesale price of 25 food commodities "selected and arranged to represent a theoretical family's food budget." As a matter of fact this curve does not indicate the cost of living, although it provides a basis for estimating the food element of the living cost of the near future. The food cost of living is indicated by the lower curve in Fig. 1, which is the average retail price of 22 articles of food, as selected and weighted by the United States Bureau of Labor Statistics.

With wholesale prices falling 45 points from Aug. 1, 1919, to Nov. 1 of that year, retail prices moved as follows: August 192, September 188, October 189, November 192, the net change being zero. This should be sufficient to show that the wholesale market is not an index of the cost of living. It is an index of industry, not of consumption.

Again, when wholesale prices began to advance in November, 1919, retail prices had been rising since Sept. 1. Wholesale prices reached the peak in June, 1920, and since then have been falling. In August, 1920, retail prices began the long swing downward and are now 52 per cent above 1913 figures, but 31 per cent below the peak of 1919-1921. The curve appears to be flatten-

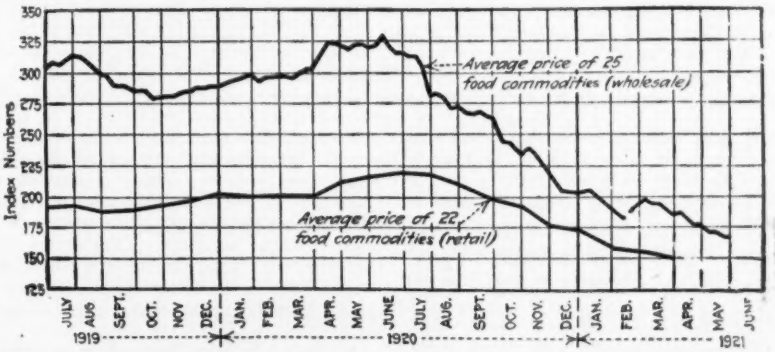


FIG. 1. PHASE DIFFERENCE OF WHOLESALE AND RETAIL FOOD TRENDS

Fig. 2 shows long period trends of labor rates and retail prices of food. The curve for farm labor at harvest time, without board, which agrees most nearly with common construction labor, runs back to 1866. The "deflation" period following the civil war was about 12 years. The long upward movement of prices of both labor and materials began in 1897 and continued with several negligible fluctuations until the end of 1915. The explosion of the next four years is graphically portrayed by this chart. The government statistics are collected yearly and therefore available figures do not extend beyond 1920.

Accepting the data in Fig. 1, the cost of food has decreased 16 per cent this year. Food, though the prime necessity of life, is by no means the sole. The innumerable items that go to make up the family budget can be gathered into five groups: Food, clothing, housing,

fuel and lighting, and miscellaneous. Expert consideration assigns the following percentages of total expenditure to these groups: Food 40 per cent, clothing 17, fuel and lighting 6, housing 14, miscellaneous 23. The miscellaneous group includes such items as doctors' bills, carfares, amusements, and the like.

The best figures available are probably those of the Bureau of Labor Statistics, but these are wholesale prices except in the single case of foods. It has been demonstrated that a decline in the wholesale market is not followed immediately by a drop in retail prices. *Engineering News-Record* has calculated that the retail decline is 36 per cent less than the wholesale. Using this measure it is possible to present the following table showing the decline in the cost of living since the peak in 1921:

	Per Cent of Total Expenditure	Per Cent Change in Retail Prices	Per Cent Change of Family Budget
Food	40	—31	—12.4
Clothing	17	—31	— 5.3
Housing	14	+45	+ 6.3
Fuel and lighting	6	0	0.0
Miscellaneous	23	—10	— 2.3
Net Change			—13.7

The real cost of living has fallen about 14 per cent throughout the country.

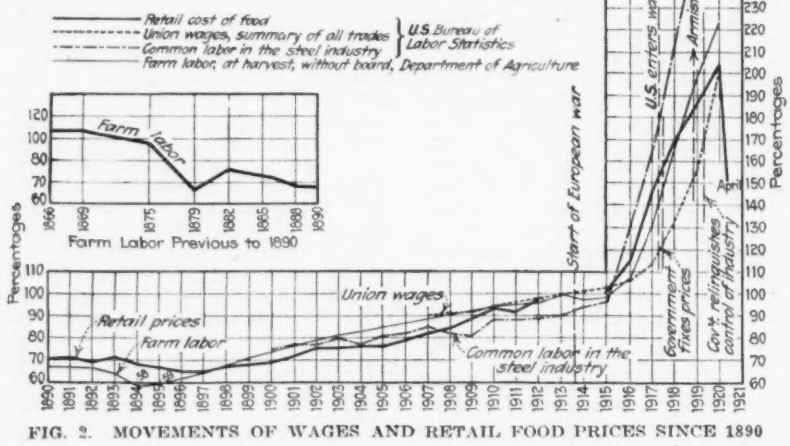


FIG. 2. MOVEMENTS OF WAGES AND RETAIL FOOD PRICES SINCE 1890

Bids Received on Milwaukee Sewage Disposal Plant Foundation

Bids were recently opened by the sewerage commission of the city of Milwaukee for the construction of the foundation for the sewage disposal plant on Jones Island. Bids were also received on a pile and concrete foundation for a power house. Eleven contractors bid for the foundation work for the sewage disposal plant, the low bid for furnishing and driving 787,250 lin.ft. of piling being $234,600. Of the twelve bidders who bid upon the pile and concrete foundation for the power house the low bid was $79,670. The engineer's preliminary estimate on this part of the work was $75,000. The complete plant will cost several million dollars.

Adjust Jersey Freight Rates on Road-Building Material

The New Jersey Public Utility Commission announced May 26 that an increase on intrastate freight rates for sand, gravel and crushed stone of 15 per cent on rates fixed by the Interstate Commerce Commission for the interstate carrying of these commodities has been allowed the railroad companies operating in New Jersey.

On July 29, 1920, the Interstate Commerce Commission allowed the railroad companies an increase of 40 per cent on freight rates including sand, gravel and crushed stone. Subsequently the railroad companies notified the utility commission that the increase would be put into effect on shipments between points entirely within the state. This action of the carrying companies drew a vigorous protest from contractors throughout the state, some of whom were engaged on state road work.

Several hearings were held by the utility board and it is now decided to forbid the increase of 40 per cent charged by railroads in interstate traffic, but it is also found by the board that a rate increase of 15 per cent, added to rates already existing and authorized by the Interstate Commerce Commission, would not be unjust or discretionary. The increase of 15 per cent allowed by the utility board will apply only to shipments of sand, gravel or crushed stone in transit between points in this state. The 40 per cent increase allowed by the Interstate Commerce Commission to be charged on shipments between New Jersey and another state will not be affected utility board's decision.

Baldwin Reservoir Contract Let

The city of Cleveland last week let a contract for building the 125,000,000-gal. Baldwin reservoir to the Hunkin-Conkey Construction Co., 601 Century Bldg., Cleveland, Ohio. The contract price was $2,052,241, 10 per cent under the engineer's estimate.

Deadlocks Continue in Building Trades Wage Disputes

Deadlocks continue in the settlement of wage disputes in the building industry in many cities. In others arbitration boards are hearing arguments, and in one instance the failure of an arbitration board to arrive at an agreement has resulted in the adoption of an open-shop policy by the contractors.

In Kansas City the arbitration board is now hearing arguments as to why wages should or should not be reduced. The arbitration board in Terre Haute failed to agree upon what was an equitable building wage basis, and in consequence the contractors are pursuing an open-shop policy. In Newark, N. J., though the open-shop plan of construction has been in effect for several weeks, it is reported that a re-opening of the question is being considered, news dispatches reporting that invitations had been received by various union business agents to attend a conference with the contractors.

Last week contractors in Springfield, Mass., voted a 15 per cent cut in wages effective immediately. Initial steps toward a reduction in building trades wages were taken also last week by the wage board in Cincinnati. The wage board is a permanent co-operative organization to whose decisions both certain employers and certain union organizations adhere.

After coming within 2½ cents an hour of an agreement, factions in Davenport, Iowa, are at a deadlock. The contractors are offering to pay 85c. for all building trades mechanics, except bricklayers and plasterers who shall receive $1 an hour.

New York Cities

All mechanics and laborers in Albany, N. Y., are on strike. The Tri-City Council, composed of exchanges of Albany, Schenectady, and Troy, is standing solidly united in the fight for a reduction in wage scales. Many Albany employers have started to run open shops, and the report is that no difficulty is experienced in securing needed men. Albany contractors are fighting for a reduction of 25 per cent from existing scales.

During the latter part of March the contractors of Rochester, N. Y., voted a 15 per cent reduction in all wages. The mechanics in all trades went out on strike on April 1 and on May 9 the proposed new agreement was withdrawn by the contractors who virtually agreed upon an open-shop plan of construction. In Buffalo contractors are operating open shops, the only changes in the past few weeks being that the bricklayers have called off their strike and have decided to accept $1 an hour under the conditions which the contractors may impose.

An approximate wage cut of 15 per cent in all lines is what the employers propose for the building trades in Trenton, N. J. The Trenton Master Builders Exchange gave mechanics until June 13 to accept the wage cut. The

bricklayers, masons, and plasterers union has already rejected the proposition, and the master masons association has severed relations with the union. It was reported that the master builders intend tying up all building operations in Trenton until workmen accept the cut in wages. An official announcement is to the effect that San Francisco contractors have severed all relations with union organizations, and, hereafter, will pursue an open-shop policy.

Increased Demand Reduces Number of Idle Freight Cars

Increased demand, particularly for coal and box cars, has resulted in a further reduction in the number of surplus or idle freight cars throughout the United States according to reports received from the railroads of the country by the car service division of the American Railway Association. On May 31 the average number of cars of all kinds in excess of current freight requirements was 394,040 or 28,783 below what it was on May 23.

Surplus box cars totaled 155,040 which was a reduction of 13,232 cars in eight days. Stimulation of coal movement through the re-opening of lake navigation also resulted in a reduction in the number of surplus coal cars, the total on May 31 being 165,102 compared with 176,442 on May 23 or a decrease of 11,340 cars.

West Coast Lumber Production

According to a recent bulletin issued by the West Coast Lumbermen's Association, for the week ended June 4, 112 mills in western Oregon and western Washington reported a production of approximately 54,000,000 ft. b.m., which is 32 per cent below normal. New business totaled 51 000,000 ft. b.m. and shipments 57,000,000 ft. b.m.

Louisiana Adopts Tax Exemption Law For Dwellings

The Constitutional Convention of Louisiana has adopted an amendment to the taxation schedule in the new basic law, whereby authority is given the cities of New Orleans and Shreveport to exempt from municipal taxes until Dec. 31, 1925, all dwellings constructed after the adoption of the Constitution and actually occupied by the owners. This new law is intended to give impetus to home building and to overcome a shortage of houses estimated at about 3,000.

Reduction in Number of Metal Lath Weights Recommended

Reduction of the number of weights of metal lath from 150 to 3 will be recommended by the Bureau of Standards at the meeting of the Association of Metal Lath Manufacturers, at Cleveland, June 21.

Construction Articles in This Issue

Filling High Viaducts on the Philadelphia and Reading Railway Page 1020

Building the Maricopa County Concrete Roads Page 1026

Earth Fill Irrigation Dam Has Some Novel Features Page 1030

Proposed Ad Valorem Tax on Dressed Lumber Opposed

Having learned that the Ways and Means committee of the House of Representatives is considering a duty of 25 per cent ad valorem on dressed lumber, the domestic lumber industry is protesting emphatically against such action. It is claimed that the lumber industry has not asked for a duty and that it does not want it.

Osgood Shovel Equipped with Continuous Tread Trucks

The Osgood Co., Marion, Ohio; has recently developed a continuous-tread mounting for the Osgood 29, a 1-yd. revolving steam shovel, which enables it to travel over soft or uneven ground with ease. The tread belt, extending but a short distance beyond the truck frame, interferes as little as possible with operations of the dipper. The treads are of three-piece construction —an open-hearth annealed steel casting to which are bolted a heavy steel pan,

NEW CONTINUOUS-TREAD OSGOOD SHOVEL

reinforced by heavy maple blocks, which forms a firm and smooth tread for hard use. The tread belts are so constructed as to enable either side to be adjusted independent of the other. It is propelled by direct-gear drive, and the fact that the shovel rests on two heavy steel billets allows the driving shaft to be free from weight. The driving shaft extends the entire width of the shovel and is supported by three large bearings of heavy pattern.

The new Osgood can be equipped with steel boom, extra drums, etc., for converting it into a crane, clamshell or dragline outfit.

Street and Road and Building Work Active

Analysis of the contracts let during the past week, as reported in *Engineering News-Record*, show steady activity in the construction of streets and roads and miscellaneous buildings, such as lofts and educational, amusement, religious, bank and office and store structures; and a strengthening of industrial work. Value of street and road contracts alone was $11,131,587, and of buildings, $15,026,514. Industrial contracts totaled only $2,074,307, though the number of projects was large, including new textile mills and a rubber products plant. Another noteworthy fact in the analysis of contracts let is the number of repaving projects put under contract.

The total value of all contracts let was $30,309,642.

Wage Adjustments Made in the Steel Trade

The Brier Hill Steel Co., Youngstown, Ohio, has announced a 15 per cent reduction in the salaries of all officials and employees, effective June 16. On this date, also, the Jones & Laughlin Steel Co., Pittsburgh, abolishes all overtime. Payment of time and a half for overtime was eliminated several weeks ago by the Cambria Steel Co., Midvale Steel Co., Youngstown Sheet and Tube Co., and most of the other independents. According to press despatches a further reduction is probable in July.

Los Angeles Votes Against Bond Issue for Sewers

In the election, June 7, the city of Los Angeles voted against the outfall sanitary and sewer bond issue of $12,850,000, which the special sewage disposal commission of Los Angeles had recommended be increased to $14,000,000, for trunk sewers and sewage disposal. The vote was 50,038 against 30,805 for the issue. It is not considered that the vote directly reflects the sentiment of the community in regard to this bond issue since it was involved in other issues and party politics.

The recommendations of the sewage commission, consisting of George W. Fuller, George C. Whipple, and William Mulholland, appeared in *Engineering News-Record*, May 5, p. 784, in the form of a brief news report. The recommendations of the commission in more detail will be published in an early issue.

Bids Soon To Be Asked on Detroit Street Railway Buildings

Repair shops, a transportation and office building, and an inspection car house are soon to be constructed by the Detroit Municpal Street Ry. as soon as condemnation proceedings have been completed and the 17-acre site made

available. The estimated cost of the general car-house, repair shop, and transportation building is approximately $1,000,000. Plans have been prepared by the railway's engineers and bids will be asked for the fabrication and erection of the structural steel frames and for furnishing the construction materials. The buildings will be constructed by the city forces.

Considerable progress has been made by the Detroit Municipal Street Ry. in carrying out the construction program begun last March, calling for the construction of 82 miles of street railway this season. To date the construction work is ahead of schedule, for up to May 15 31.2 miles of single-track excavation had been completed, 19 miles of single track had been laid, and 8.2 miles of single track paved in.

The material and construction equipment are being purchased by the city and construction is being carried on by the city forces under the direction of Joseph F. Goodwin, general manager of the municipal system provided for by the $15,000,000 bond issue voted last year.

Paving work and sewer construction are being carried out on a greater scale than ever this year. Greater rapidity in carrying out the city's construction program is aimed at and it is also desired to open the closed streets as soon as possible.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of June 2, the next on July 7

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$3.33	—$4.00	$4.50	$3.23	$3.51	$4.65	$4.35	—$4.60	$5.00
Structural rivets, 100 lb	4.85	5.25	5.80	4.88	5.30	6.25	6.40	—5.50	8.50
Reinforcing bars, ¾ in. and larger, 100 lb	3.23	3.25	3.75	3.13	3.53½	4.32½	2.35	+4.00	4.25
Steel pipe, black, 3½ to 6 in. lap, discount	52%	50.65-5%	45%	58½%	51.9-5%	29%	49.80	47½%	5%
Cast-iron pipe, 6 in. and over, ton	54.00	59.22	65.00	—54.10	62.80	70.00	85.90	—65.00	75.00
Concreting Material:									
Cement without bags, bbl	2.80(del.)	—2.60	2.60	2.17	2.26	3.10	3.09	3.10	—3.40
Gravel, ¾ in., cu.yd	2.50	2.80	3.50	2.25	2.00	2.50	2.25	1.50	1.50
Sand, cu.yd	1.25	1.62½	3.00	2.25	1.00	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	2.15	2.50	2.80	2.50	2.25	3.50	2.25	3.50	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	43.00	40.00	50.00	55.00	37.00	47.00	27.00	28.50—110.00	
Lime, finishing, hydrated, ton	21.00	22.50	27.50	20.00	29.00	32.00	25.40	24.00	30.00
Lime common, lump, 200 lb. bbl	3.30	1.60	3.00	1.65	—1.50	3.10	2.25	2.75	15.00
Common brick, delivered, 1,000	18.40	—11.50	14.50	12.00	17.00	14.00	18.00	16.00	18.00
Hollow building tile, 4x12x12, block	Not used	.14	.13	.12	092	.09	.12½	.11	.19
Hollow partition tile 4x12x12, block	....	.15	.13	.096	092	.10	.14½	.12	.....
Linseed oil, raw, 5 bbl. lots, gal	.80	+.78	.90	—.87	.91	.95	.96	.79	.84
Common Labor:									
Common labor, union, hour	.75@.80	.35	.....	1.00	.50	.50@.63½	.81½	.75	.....
Common labor, non-union, hour	.....	.25	.35@.45	.45	.50	.37½@.50	50@.55	.50	.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent, 45@50 means a range of 45 to 50 per cent. Charge of 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over. **New York** quotations are delivered except tiles, which are "on trucks." Sand, gravel and crushed stone are quoted alongside dock. **Chicago** quotes hydrated lime in 50-lb. paper bags. **Minneapolis** quotes on fir instead of pine. Brick and hollow tile delivered. **Denver** quotes sand and crushed stone quote at pit. Common labor not organized. **Denver** quotes cement "on tracks"; gravel and sand at pit, stone on cars, lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. **Atlanta** quotes sand, stone and gravel per ton instead of cu.yd. **Dallas** quotes lime by the 180-lb. bbl. Steel and crushed stone are quoted f.o.b. cars, other materials delivered. **San Francisco** quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Lumber prices are delivered "at ship tackle in San Francisco ex mill." **Seattle** quotes on Douglas fir instead of pine; and on lime in paper bags. **Montreal** quotes sand stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. No organized common labor in Montreal.

Changes Since Last Week

Reports are general of a deep depression in the steel trade, warranting an official price decrease. Price shading is becoming general, Chicago reporting that almost any steel product can be purchased at 25c. under the list. Structural shapes are down 30c. in Seattle, and reinforcing bars and rivets also have fallen.

The base wholesale price of Southern pine in the New York market is $43 per M. ft. b.m. The price in Montreal is $110, a decline of $10 since the last report. There has been a slight stiffening in Douglas fir at Seattle. The West Coast Lumbermen's Association advises that for the last week of May 112 mills in Western Oregon and Western Washington reported production at 56,591,246, which was 30 per cent below normal. Curtailment of production helps explain the strengthening of the lumber market.

Cast-iron pipe is selling for about the same in Chicago as in New York, $54.10. Minneapolis quotes lump lime at $1.50 per 200-lb. bbl., as against $2 a week ago.

As to labor—Chicago advises that the end of the construction tie-up is in sight. Judge Landis has been accepted by both sides as arbitrator. Work is resumed at once at the old scale of $1.25 per hour for skilled labor, $1 for unskilled, the new rate to be effective upon the rendering of the arbitration decision, and to remain in effect until May 1, 1922. About 20,000 building trades employees returned to work on June 14. In February, 1922, the arbitrator is to hear evidence and to set a schedule that shall be effective until May 1, 1923. Settlement, if effected as outlined, will mean the resumption of work to the value of $20,000,000 and the probable opening of needed work estimated at $100,000,000.

The San Francisco Building Council has announced acceptance of an arbitration board to consider the decision reducing wages of seventeen unions on the closed-shop basis. Builders, refusing the concession, state that they will adhere to the open shop and a reduction of 7½ per cent.

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